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**Electrical Exhibits at the World's Fair.** PREPARATIONS for the electrical work of the World's Columbian Exhibition at Chicago are gradually being pushed forward, in spite of the many delays in the general work and the unfortunate sickness of Mr. Barrett. That gentleman, however, is now actively on the warpath in defense of his department. It rather needs defending just now, for it is hard to make the architects realize what enormous dimensions the electrical part of the exposition will assume. However, Mr. Barrett can be trusted to look after the matter and see that his section is properly represented. Its success has been threatened by more than one of the wrangles that beset the great exposition, as when it was suggested to place the electrical exhibit on made land on the lake front, or to divide it, providing an electrical circus for the amusement of the people in one part and more serious exhibits in another. The chief of the department has successfully steered clear of these obstacles, and will not fail to avoid the ones that are now thrown in his way.

**The Electrical Exhibition at Frankfort.** MAY 16 will be opened an international electrical exhibition that promises to be thoroughly representative of continental industry, besides including apparatus from all parts of the world. Most of the buildings are now nearly ready, and it is expected that at the formal opening a very large number of exhibits will be in place. It will last all summer, closing some time during the month of October, and during its continuance will be an object of interest to electricians of every country. From an engineering standpoint the feature of the exhibition will be the electrical transmission of power 100 miles from Lauffen-on-the-Neckar. The method by which this is to be accomplished we have described at length in these columns. It is only necessary to say that it bids fair to be carried out as predicted, has excited no little enthusiasm, and has received every encouragement. America will be represented by not a few distinguished men, as mentioned elsewhere in our columns, and one of them, well known to electricians in this country and abroad, Mr. Carl Hering, goes as the special representative of THE ELECTRICAL WORLD at Frankfort. We shall pay especial attention to the details of the great exhibition, and our correspondent, it is needless to say, will keep us thoroughly informed as to everything of interest that the efforts of Continental Europe have been able to gather. Certain it is that Frankfort will have an exhibition of electrical appliances and machinery thus far unequalled, and not easy to surpass, even in our own progressive country.

**Rapid Transit Plans.** THE deliberations of the rapid transit commissioners for the relief of New York have been long drawn out and careful, and it is now about time to hear something definite from them. The premature report that appeared in the daily press a few weeks since, to which we called attention at the time, was in all probability groundless, and there is reason now to hope that the immense amount of ingenuity and engineering skill that has been brought into play for solving the great problem may not go for nothing. Underground, viaduct and overhead roads almost innumerable have been brought to the attention of the commission, but the impracticable ones have been gradually weeded out, and the number now seriously to be considered is very small. The two most prominent ones, perhaps, are the Reno, described in THE ELECTRICAL WORLD a few weeks ago, and the Greathead system, that has been industriously exploited on the strength of its London success. Nearly all the other plans involve desperate feats of engineering daring or enormous expense. Something must be done, and done quickly, and we sincerely hope that the commission will throw the weight of what authority it possesses in favor of some practicable plan at an early day. It is almost too much to hope that any extensive system of rapid transit can be carried out in this city without involving atrocious jobs of one sort or another; but public feeling is such that even a steal from the city treasury would be welcomed if through it there were any real hope of relief. Though the promoters of the various plans may be ever so honest and straightforward, they have a hard task before them, and will have general encouragement and sympathy in any efforts they may make for the righteous administration of their work.

**The Deadly Trolley Again.** THE trolley wire is again before the public. One would have supposed, after the desperate efforts that were made to prevent electric traction in the annexed district, and the favorable report of the Board of Electrical Control and the Railway Commissioners, that opposition to modern improvements would at least partially have subsided. But just as soon as it was suggested to convert certain of the Brooklyn horse car lines into electric lines the same insensate, frantic opposition to the trolley wire that has been the laughing stock of intelligent people in cities where electric traction now exists came to the front, and a vigorous fight is now going on. The daily press is especially active in sensational attacks on the trolley system. There are those who insinuate that the elevated road companies could tell something about the cause of certain phases of public opinion, but this of course is only surmise, as those most immediately interested in such matters do not care to make their private business public. It is intensely amusing, from a psychological standpoint, to watch the vagaries of the human mind when the subject of electric wires in broached. If one may judge from the furious jeremiads occasionally printed the usual train of reasoning followed runs something after this wise: Men have been killed by arc light circuits; the trolley wire might, could, would or should be an arc light circuit; therefore it is unspeakably deadly and must be prohibited at all hazards. The exquisite logic of this syllogism will at once appeal to every electrician. But sometimes the attention of objectors is called to the fact that no man has ever yet been killed on a railway circuit; then there is nothing to do but fall back on the occasional death of a horse from contact with the trolley wire, and the following interesting argument results: Animals have been killed by contact with the deadly trolley wire; man is an animal; therefore man must infallibly be killed if he comes within reach of the devastator that you propose to hang up in our streets. Against such efforts of intellect as these, friends of electric traction can do nothing. Their brains are incapable in their present state of education of grasping this remarkable course of alleged reasoning; in fact, we strongly suspect that nothing short of a course at Bloomingdale could train the untutored mind of the electrician into such marvelous ways of thinking.

**The Electrical Reduction of Aluminium.** So much has been heard recently of cheap aluminium that a description of the methods of obtaining it is just now particularly appropriate. Mr. Brown's paper, read before the American Institute of Electrical Engineers, and published elsewhere in our pages, is therefore especially welcome. It is devoted more particularly to a description of a single process, the Heroult, now in operation at Boonton, N. J. This method of obtaining aluminium is, like the other modern processes, strictly electrical. Mr. Brown's paper gives a clear idea of the procedure for the production of aluminium bronze, but is, unfortunately, silent as to the details of the reduction of pure aluminium from its ores. There are at present three successful electrical processes for the production of aluminium and aluminium bronze; possessing certain features in common. Of these the Cowles is perhaps the earliest, and is peculiar in employing the intense heat of the electric arc for smelting pure and simple. Roughly speaking, the method consists in forming an enormously powerful electric arc in the interior of an infusible crucible, making a genuine electric furnace, in the fierce heat of which aluminium oxide in its native form of corundum can be reduced in the presence of carbon. If no metal is present in the furnace to combine with the freed aluminium, the success of the operation is interfered with by the formation of carbide of aluminium. The process, therefore, has up to the present shown itself best fitted for the production of alloys. For this purpose, with the alumina and carbon in the furnace is mixed granulated copper that combines with the aluminium as fast as the latter is set free. The result is a bronze rich in alumina, containing as high as 40 per cent. of that remarkable metal. This bronze can then be employed in the formation of similar alloys with varying percentages of aluminium. The Heroult process, as described by Mr. Brown, consists in passing a tremendously powerful current between a hard carbon anode and a cathode formed of a carbon-lined crucible containing molten copper and alumina. At the start bits of copper are thrown into the crucible and melted by the current until a considerable quantity of the molten metal is in the bottom of the crucible; then pure alumina is added; this floats upon the top of the copper, and the anode is then raised so as to leave a small space in which a process of reduction partly electrolytic and, probably, partly by smelting can take place. The alumina is introduced in small quantities at frequent intervals and the reduced metal combines with the copper. The process is continuous, as the crucible can be tapped at any time and a portion of the alloy removed. Such is the Heroult process for manufacturing bronze From figures obtained from Heroult reduction works abroad the production of aluminium is too great to be accounted for wholly by electrolytic action, so that in all probability smelting and electrolysis go on together. Mr. Brown does not give the details of the operation for producing pure aluminium, but from the description of it contained in the English patent it appears to be electrolysis of a fused mixture of cryolite, the double fluoride of aluminium and sodium, with pure alumina. The cryolite is probably the substance decomposed in this case, the oxide serving to take up the fluorine set free and keep up the supply of fluoride. The third process, employed by the Pittsburgh Reduction Company, working under patents granted to Mr. C. M. Hall, is more purely electrolytic in its character, but closely resembles that just mentioned. A carbon-lined crucible, containing molten fluorides of calcium, sodium and aluminium, these latter being obtained by melting together cryolite, aluminium fluoride and fluorspar, is subjected to the action of a powerful electric current from a carbon anode. Pure aluminium is reduced freely from this mixture, and alumina is added for the purpose of at once keeping up the supply of ore and taking up the nascent flourine that is produced. The exact reactions are not altogether well known, but are substantially as mentioned. The whole process is a continuous one, the aluminium being removed from the bottom of the crucible by ladles whenever necessary. Both the Heroult and the Hall processes are readily applicable to the production of pure aluminium, but it should be remembered that this can only be produced by using pure materials at the start. The very best results are only obtained by using artificially purified materials instead of relying on the natural ones. As aluminium is peculiar sensitive to small impurities the utmost care in this particular is necessary; even the crucible may contain enough silicon to interfere with the production of pure metal. In spite of the fact that, from its low atomic weight, the electrolysis of aluminium is anything but an economical process, electrical power can now be obtained so cheaply that such a method becomes not unlike other known means for producing aluminium. A point has now been reached when that metal can be obtained at a price sufficiently low to permit its extensive use if desirable. The problem now before the metallurgist is to discover alloys of aluminium that are possessed of good mechanical properties, and, at the same time, retain the invaluable property of lightness that is the chief characteristic of that beautiful metal.

## Latest Foreign Electrical News.

*(By Cable from our Regular Correspondent.)*

London, April 27, 1891.—Major Cardew's paper before the Institution of Electrical Engineers on Thursday last dealt with electrical shocks from contact with high pressure conductors, and led to a very amusing discussion. Among the speakers were: Dr. Fleming, Mr. Mordey and Mr. Addenbrooke, who gave results of their personal experience in encounters with high-tension wires.

The arc light is again in court. This time there is difficulty at Bath with respect to the so-called candle power of the arcs. The contract with the municipality calls for lights of 1,200 c. p., and the authorities assert that they only get one-quarter of this, and propose to make it interesting for the company.

The central station for the lighting of Birmingham is now in operation; it was inaugurated on Saturday last by the mayor.

Information reaches us of a very interesting Thomson-Houston installation started on last Saturday at St. Brieuc, France. The power is transmitted over eight miles on the alternating system, with the machines coupled in parallel.

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## Chronological History of Electricity, Galvanism, Magnetism and the Telegraph, from B. C. 2637 to A. D. 1888.—Part I.*

BY P. F. MOTTELAY.

B. C. 285 to 247.——Ptolemy (Ptolemæus) II., surnamed *Philadelphus*, or the brother-loving, son of Ptolemy *Soter*, ordered Timochares, the architect of the palace, to suspend the iron statue of Arsinoë in the temple of Pharos.

Although Pliny says (liber 34, cap. 14) that the statue was never completed, owing to the death of both Ptolemy and his architect, Ausonius (Decimus Magnus), Roman poet of the fourth century, asserts the contrary in his most important work, "Mosella" (verse 315), translated by De la Ville de Mirmont, the first edition of which was published by Ugollet at Venice in 1499. Therein it is said: "Timochares (and not Dinochares, Dinocrates, Democrates or Chirocrates) suspended the statue in midair (*dans les hauteurs aériennes du temple*). . . . Under the ceiling-vault crowned with loadstones, a bluish magnet draws, by means of an iron hair, the young woman it holds in its embrace."

King Theodoric alludes ("Cassiodor variar," lib. I. epist. 45) to a statue of Cupid suspended in the temple of Diana at Ephesus (one of the Seven Wonders of the World), and St. Augustine ("De Civitate Dei," XXI., 6) speaks of a bronze figure suspended in the temple of Serapis at Alexandria by means of a magnet attached to the ceiling. See De Mirmont, "La Moselle," 1889; "Commentaire," pp. 93 and 95; Knight's "Mechanical Dictionary," vol. II., p. 1,370; "Eng. Cyc. Biography," vol. I., p. 363.

B. C. 200.——Polybius, a Greek statesman and historian, describes (lib. 10, cap. 45, "General History") his optical telegraph *pyrsia*—because the signals were invariably produced by means of fire-lights—an improvement upon the modes of communication previously suggested by Cleoxenes and Democlitus. It consisted of a board upon which the twenty-four letters of the Greek alphabet were arranged in five columns, each column having five letters (the last space being vacant). The party signaling would hold up with his left hand a number of torches representing the column from which the desired letter was to be taken, while in the right hand he would hold up to view as many torches as were necessary to indicate the particular letter required. See Rollin's "Ancient History," 9th Dundee, vol. VI., p. 321; "Emporium of Arts and Sciences," vol. I., pp. 296 to 299; "Penny Encyclopedia," vol. XXIV., p. 145.

B. C. 60 to 56.——Lucretius (Titus Lucretius Carus), Roman poet, alludes to the magnet in his poem "De Rerum Natura" (The Nature of Things), thus translated by Dr. Thomas Busby, London, 1813, book VI., verses 1,045 to 1,059:

"Now, chief of all, the Magnet's powers I sing,
And from what laws the attractive functions spring.
(The Magnet's name the observing Grecians drew
From the Magnet's region where it grew.
Its viewless, potent, virtues men surprise;
Its strange effects they view with wondering eyes,
When, without aid of hinges, links or springs,
A pendent chain we hold of steely rings,
Dropt from the stone; the stone the binding source,
Ring cleaves to ring, and owns magnetic force;
Those held superior those below maintain;
Circle 'neath circle downward draws in vain,
While free in air disports the oscillating chain.
So strong the Magnet's virtue as it darts
From ring to ring and knits the attractive parts."

The rendering of the same by Thomas Creech, A. M., London, 1714, book VI., verses 894 to 989, likewise deserves reproduction here:

"Now sing, my muse, for 'tis a weighty cause.
Explain the Magnet, why it strongly draws,
And brings rough Iron to its fond embrace.
This Men admire; for they have often seen
Small Rings of Iron, six, or eight, or ten,
Compose a subtile chain, no Tye between;
But, held by this, they seem to hang in air,
One to another sticks and wantons there;
So great the Loadstone's force, so strong to bear!
* * * * * * * *
First, from the Magnet num'rous Parts arise,
And swiftly move; the Stone gives vast supplies;
Which, springing still in Constant Streams, displace
The neighb'ring air and make an Empty Space;
So when the Steel comes there, some Parts begin
To leap on through the Void and enter in.
* * * * * * * *
The Steel will move to seek the Stone's embrace,
Or up or down, or t' any other place,
Which way soever lies the Empty Space."

* Continued from The Electrical World, April 25, 1891.

The transmission of the magnetic attraction through rings or chains is also alluded to in Plato's "Ion," p. 533, D. E., Ed. Steph; by Pliny, lib. 34, cap. 14; St. Augustine, "De Civ. Dei," XX., 4; Philo, "De Opif. Mundi," D. ed. 1691, p. 32; likewise by the learned Bishop Hall, "the English Seneca," as follows: "That the loadstone should by his secret virtue so drawe yron to it selfe as that a whole chaine of needles should all hang by insensible points at each other, only by the influence that it sends downe from the first, if it were not ordinary, would seeme incredible." ("Meditations," 1640, con. 3, par. 18.)

A. D. 50. — Scribonius Largus Designatianus, Roman physician, relates (in chapters I. and XLI. of his "De Com-

A Chinese Compass of the Second Century, A. D.

positione Med. Medica") that a freedman of Tiberius called Anthero was cured of the gout by shocks receive from the electric torpedo, and Dioscorides advises the same treatment for inveterate pains of the head ("Torpedo," lib. 2). Other applications are alluded to by Galen ("Simp. Medic.," lib. 11; "Paulus Ægitina," lib. 7, *vide* "Ency. Met.," art. "Electricity," IV., p. 41.) See also Bertholon, "Elec. du Corps Humain," 1786, vol. I., p. 174.

Fahie states ("History of Electric Telegraphy," p. 172) that, along the banks of the Old Calabar River, in Africa,

A Japanese Magnetic Chariot of the Middle Ages.
[From an ancient Japanese encyclopedia.]

the natives employ the electrical properties of the *gymnotus* for the cure of their sick children. They either place the ailing child beside the vessel of water containing the animal, or the child is made to play with a small specimen of the fish.

A. D. 121.——The Chinese knew of old the magnet, its attractive force and its polarity, but the most ancient record made of the peculiar property possessed by the loadstone of communicating polarity to iron is explicitly mentioned in the celebrated dictionary "Choue Wen," which Hin-tchin completed in A. D. 121, the fifteenth year the reign of the emperor Ngan-ti of the Han dynasty.

This dictionary contains a description of the manner in which the property of pointing with one end toward the south may be imparted to an iron rod by a series of methodical blows, and alludes to the "stone with which a direction can be given to the needle."

"In Europe it has been thought that the needle had its chief tendency to the North pole; but in China the South alone is considered as containing the attractive power." (Sir G. Staunton, "Account of an Embassy, etc." London, 1797, vol. I., p. 445.)

Le Père Gaubil, who was sent to China in 1721 and died in Pekin 1759, says ("Histoire . . . de la dynastie de Tang, in Mémoires concernant, etc.," vol. XV.) that he found, in a work written toward the end of the Han dynasty, the use of the compass distinctly marked to distinguish the north and the south. He also states, though doubtless erroneously, that that form was given it under the reign of Hian-Tsoung.

With reference to the magnetic attraction to the pole, it is well to bear in mind that no allusion whatsoever is made thereto by any of the writers of classical antiquity. This much has already been stated under date B. C. 1,000–907. It certainly appears to have escaped the attention of the ancient Greeks and Romans, whose admiration, according to the learned French physician Falconet ("Dissert. Hist. et Crit."), was excited solely by the attractive property of the loadstone.

The Rev. Father Joseph de Acosta ("Natural and Moral History of the Indies," tr. C. R. Markham, C. B. lib. I. cap. 16) thus alludes to the above subject: "I finde not that, in ancient bookes, there is any mention made of the use of the Iman or Loadstone, nor of the Compasse (*aguja de marear*) to saile by; yea, I beleeve they had no knowledge thereof. . . . Plinie speakes nothing of that vertue it hath, alwaies to turne yron which it toucheth towards the North. . . . Aristotle, Theophrastus, Dioscorides, Lucretius, Saint Augustine, nor any other Writers or Naturall Philosophers that I have seene, make any mention thereof, although they treat of the loadstone."

Thomas Creech, in the notes to his translation of Lucretius' "De Natura," says: "Nor indeed do any of the antients treat of this last (the directive) power of the loadstone, . . . and Guido Pancirollus justly places it among the modern inventions." See Davis, "The Chinese," 1844, vol. III., p. 12; Klaproth, "Boussole," Paris, 1834, pp. 9, 10 and 66; Azuni, "Boussole," Paris, 1809, p. 30; "Engl. Cycl. Arts and Sciences," vol. V., p. 420; "Cosmos," 1848, vol. II., p. 628.

A. D. 218.——Salmasius, in his Commentary upon Solinus, asserts that at this date amber was known among the Arabs as *Karabe* or *Káhrubá*, a word which, Avicenna states, is of Persian origin and signifies the power of attracting straws; the magnet being called *Ahang-rubá*, or attractor of iron. See "Ency. Met.," vol. IV., p. 41; Fahie, "History of Electric Telegraphy," p. 29.

A. D. 232–290.——Africanus (Sextus Julius), an eminent Christian historical writer, author of a chronicle extending from the date of the creation to A. D. 221, as well as of an extensive work entitled "Kestoi," states that the Roman generals perfected a system of readily communicating intelligence by means of fires made of different substances. See Shaffner, "Telegraph Manual," 1859, p. 19; "Appleton's Cyclopedia," 1871. vol. XV., p. 333.

A. D. 235.——It is related that one Makium, who was ordered by the Chinese emperor to construct "a car which would show the South," succeeded in doing so and thus recovered the secret of manufacture which had for some time been lost. The *American Journal of Science and the Arts* (vol. XL., p. 249) adds that from this date the construction of a magnetic car seems to have been a puzzle, . . . and the knowledge of the invention appears to have been confined within very narrow limits. De Humboldt says that the magnetic wagon was used as late as the fifteenth century of our era, and the *American Journal of Science and the Arts* states that it cannot be traced later than 1609.

A. D. 265–419.——The earliest mention or printed record of the use of the magnet for navigation appears in the justly prominent Chinese dictionary, or rather encyclopædia, "Poei-wen-yun-fou," wherein it is mentioned that there were during this period (that of the second Tsin dynasty) ships directed to the South by the *ching* or needle.

It is likewise therein stated that the figure then placed upon the magnetic cars represented "a genius in a feather dress," and that, when the emperor went out upon state occasions, this car "always led the way and served to indicate the four points of the compass." See Davis, "The Chinese," vol. III., p. 12; Klaproth, "Boussole," pp. 66 and 67; Johnson, "Univ. Cycl.," vol. I., p. 927, ed. 1877.

A. D. 295–324.——Koupho, Chinese physicist as well as writer, and one of the most celebrated men of his age, compares the attractive property of the magnet with that of amber animated by friction and heat. In his "Discourse on the Loadstone" he says: "The magnet attracts iron as amber draws mustard seeds. There is a breath of wind, that promptly and mysteriously penetrates both bodies, uniting them imperceptibly with the rapidity of an arrow. It is incomprehensible." See Klaproth, "Boussole," p. 125; "Cosmos," vol. V., p. 51.

A. D. 304.——St. Elmo (St. Erasmus), bishop of Formiæ, in ancient Italy, who suffered martyrdom about this date at Gaeta, is the one after whom sailors in the Mediterranean first named the fires or flames which are supposed to be of an electric nature, and which appear during storms either at the yard-arms, mast-heads, in the rigging or about the decks of a vessel. When two flames are seen together they are called Castor and Pollux, "twin gods of the sea, guiding the mariner to port," and are considered by seamen as an indication of good luck and of fine weather; but when only one flame is visible it is called Helena, and is supposed

to be an evil omen, "the beacon of an avenging god luring the sailor to death."

St. Elmo's fire is also known to the Italians as the fire of *St. Peter* and of *St. Nicholas*, to the Portuguese as *San Telmo* and as *Corpos Santos*, and to the English sailors as *comazant* or *corposant*.

The historian of Columbus' second voyage says that, during the month of October, 1493, "St. Elmo appeared on the topgallant-masts with seven lighted tapers." It is also alluded to by Pliny, "Nat. Hist.," lib. II., cap. 37; by Stobæus, "Eclogarum Phys.," I., 514; Livy, cap. XXXII.; Seneca, "Nat. Quœst." I., 1; by Cæsar, "de Bello Africano," cap. VI., edit. Amstel., 1686; and by Camoens, "Os Lusiades," canto V., est. 18.

"Last night I saw St. Elmo's stars,
With their glimmering lanterns, all at play
On the tops of the masts and the tips of the spars,
And I knew we should have foul weather to-day."
(Longfellow, "Golden Legend," chap. V.)

". . . Sometimes I'd divide,
And burn in many places—on the topmast,
The yards and bowsprit, would I flame distinctly,
Then meet and join. . . . "
(Shakespeare, "The Tempest," act I., scene II.)

See also "Nouvelle Biog. Générale," vol. XVI., p. 179; "Grand Dic. Universel du XIX^e siècle," of Pierre Larousse, tome VII., p. 786; Humboldt, "Cosmos," 1849, vol. II., p. 245; Becquerel, "Traité Exp.," 1834, vol. I., p. 34, and his "Résumé," chap. I.; also, Procopius, "De Bello Vandal," lib. II., cap. 2; William Falconer's "Observations, etc.," in vol. III., p. 278, of "Mem. Lit. and Ph. Soc. Manchester," 1790, translated in Italian 1791, for an account of the flames appearing upon the spear points of the Roman legions.

A. D. 400.——Marcellus Empiricus, who was *magister officiorum* in the reign of Theodosius the Great (379 to 395), states, in his "De Medicamentis Empiricis," that the magnet called *antiphyson* attracts and repulses iron. This, adds Becquerel, in his "Résumé," chap. III., further proves that these properties were known in the fourth century. See Klaproth, "Boussole," 1834, p. 12, and Harris, "Magnetism," I. and II.

A. D. 425.——Zosimus (Count), Greek historian, lived under Theodosius II. (401–450), "sometime advocate of the Treasury of the Roman Empire," wrote the history of that empire from the reign of Augustus to the year 410 A. D., wherein he is the first to call attention to the electrolytic separation of metals, *i. e.*, that the latter acquire a coating of copper upon being immersed in a cupreous solution. See Gore, "Art of Electro-Met.," 1877, p. 1.

A. D. 426.——Augustine (Aurelius, Saint), the most prominent of the Latin Fathers of the Church, finishes his "De Civitate Dei," which he began in 413, and which is considered the greatest monument to his genius. In it he tells us (Basileæ, 1522, pp. 718, 719) of the experiment alluded to by Prof. Stanley Jones at A. D. 1558–1589. He relates that while visiting Bishop Severus he was enabled to direct in any desired manner a needle affixed to a piece of cork, floating in a vessel of water upon a thick wooden table, by placing a magnet in different positions under the table, and that he saw the bishop thus readily move a piece of iron which he had placed upon a silver plate.

A. D. 450.——Aëtius, Greek physician, informs us (Aëtii, Op. lib. XI., cap. 25) that "those who are troubled with the gout in their hands or in their feet, or with convulsions, find relief when they hold a magnet in their hand." Paracelsus recommended the use of the magnet in a number of diseases, as fluxes, hemorrhages, etc.; J. J. Wecker, in his "De Secretis," advises its use for the headache, while Marcellus ("Steph. Artis. Med. Princip.," II., p. 253) and Leonardus Camillus ("De Lapidus," lib. 2, p. 131) assert that it will cure the toothache. In 1754 Lenoble constructed magnets that were readily used in the treatment of various diseases (*Practical Mechanic*, vol. II., p. 171). For others consult J. Beckmann's "History of Inventions," Bohn, 1846, vol. I., p. 43, and see also Mauduyt under the A. D. 1781 date, as well as Lovet (A. D. 1756) and the article "Somnambulism" in the "Encyclopædia Britannica."

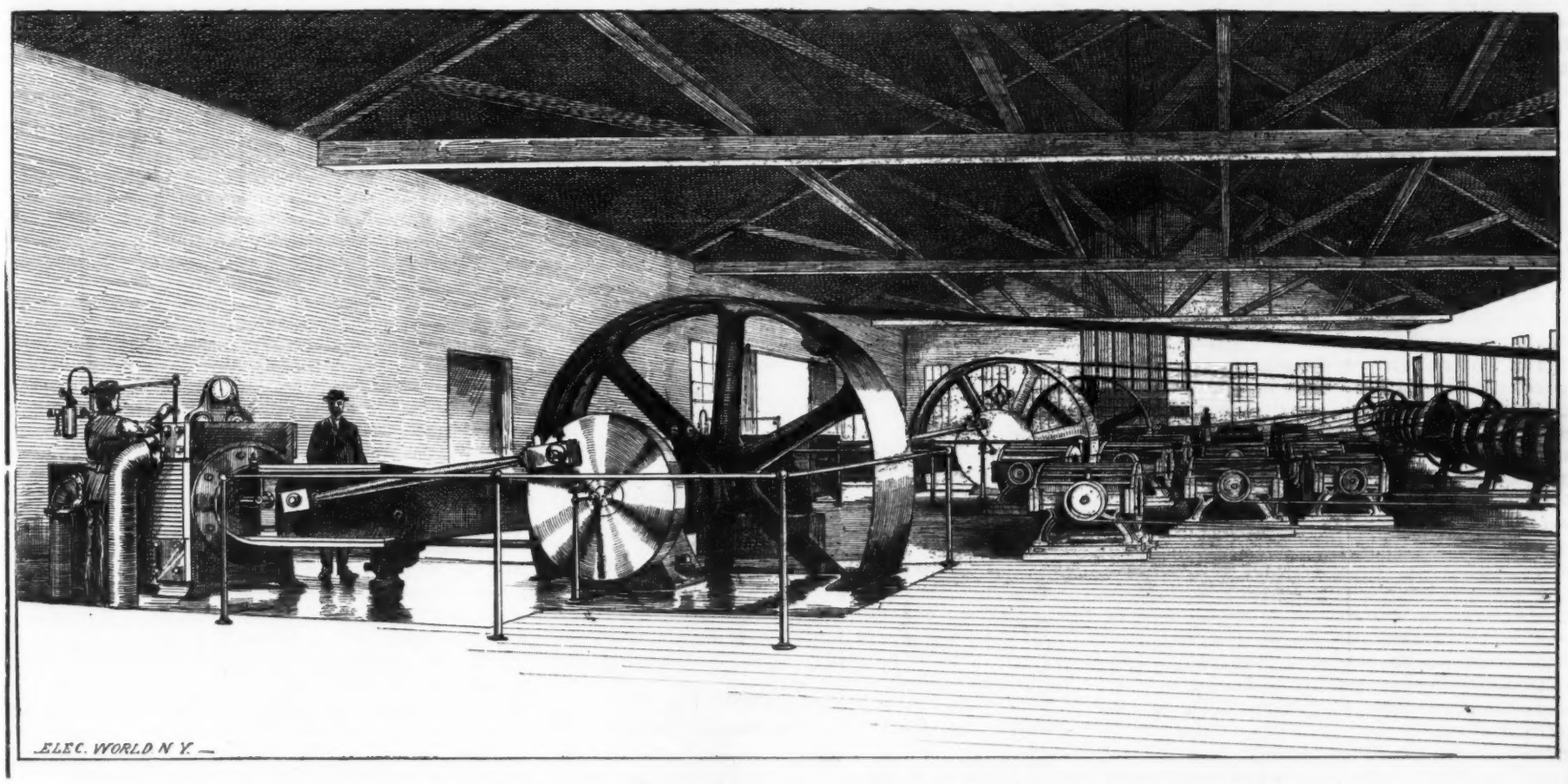
A. D. 543.——The Japanese say that at about this date the Mikado received from the Court of Petsi in Corea "the wheel which indicates the South." (Knight, "Mechanical Dictionary," vol. II., p. 1,397.)

A. D. 658.——As shown by Kaï-bara-Tok-sin, in the "Wa-zi-si," the first magnetic cars were constructed during this year in Japan; the loadstone was not, however, discovered in Japan until A. D. 713, when it was brought from the Province of Oomi. (Klaproth, "Boussole," p. 94.) The *Journal of the Franklin Institute* (vol. XVIII., for 1836, p. 69) gives a description and illustration of one of these magnetic chariots, taken from the thirty-third volume of the "Japanese Encyclopædia."

A. D. 806–820.——Between these dates, under the Thâng dynasty, were first made the cars called *Kin-Koung-yuan*, which were magnetic chariots similar to those previously known, but bearing in addition a drum and a bell. Both the latter were struck at regular intervals by an erect male figure placed at the head of the car. (*American Journal of Science and the Arts*, vol. XL., p. 249.)

A critic named Tchen-yn admits, as already stated under the A. D. 235 date, that the knowledge of the mode of construction of the magnetic cars was by no means general. "I know well," adds he, "that at the time of the Thâng, under Hien-toung (who ascended the throne 806 A. D. and reigned 17 years), a chariot was made which always showed the four parts of the earth, in imitation, it was said, of those constructed at the time of Hoang-ti. . . . Upon it stood the figure of a spirit whose hand always pointed to the South." See "Mémoires concernant l'histoire, etc.," Saillant et Nyon, Paris, 1776, vol. XIII., p. 234; also Klaproth, "Boussole," page 72.

A. D. 968.——Kung-foo-Whing is said to have invented a method of transmitting sound through wires by means of an apparatus called *thumthsein*, although no trace whatever of the latter is to be found in any of the numerous authorities herein quoted.




ENGINE AND DYNAMO ROOM OF THE NEW HAVEN (CONN.) ARC LIGHT CENTRAL STATION.

## The New Haven Arc Light Station.

The report of the electric lighting industry in New England, given in THE ELECTRICAL WORLD several weeks ago, shows how wide-awake are the people of that part of the country to the superiority of the electric light. Ten years ago it would have been hard to find a single electric light plant, but to-day the various New England States are admirably supplied with well-constructed and well-managed central stations. Mr. F. A. Gilbert, president of the Boston Electric Light Company, operating the largest plants in Massachusetts, and Mr. James English, interested in the same company, are among the most energetic workers in the field of electric light installation in that section of the country, and to these gentlemen the city of New Haven, Conn., owes its extensive light system.

Some years ago the New Haven Electric Company, with a capital of $200,000, was formed by Messrs. Gilbert and English to operate a large combined arc and incandescent light plant. It was thought at the time that the original station would be large enough to supply the needs of New Haven for many years to come, but the demands have overrun the capacity and a new station building has been built.

Many electric lighting companies now see the advantages of operating separately the arc and incandescent light systems, and the New Haven Company is to follow out this plan. Two buildings—one for the arc machinery and switchboards and one for the incandescent plant—are now usually erected when a rapid increase in business is expected. The simplicity of management and the facilities thus gained well repay the extra expenses of such an arrangement.

The new plant is to be used exclusively for the arc light system and to give more space for the increase of the capacity of the incandescent plant in the old building.

The new station building, of which we give an interior view in the accompanying illustration, is of brick, and is built on the banks of the river, where a good supply of water can be had, and near to a branch track of the railroad. The size of the dynamo-room is about 100 by 150 feet, which space affords considerable room for increase. However, the company wishes to keep abreast of the demands, and one end of the building is without a brick wall, left open, as it were, so that the station building can be enlarged lengthwise at any time. This end of the building is at present walled with corrugated sheet iron. As can be seen from the illustration, the plant comprises 14 Thomson-Houston arc dynamos, which are all about 50-light capacity, making the total capacity of the plant something like 700 lights. These machines are run from a line of counter-shafting, which is run by three 250-h. p. Greene compound tandem engines. These engines are connected to the counter-shaft through Frisbie friction clutches, and one or more engines can be disconnected as the load may vary. Besides the three main clutches, each dynamo has its individual clutch, and with this arrangement is gained perfect regulation to suit the fluctuations of the load. The Frisbie friction clutch is well adapted to the requirements of electric light installations. A "double grip" is obtained with this clutch, and the release is positive. When running open there is no wear upon the friction shoes, as the release is made through a considerable distance with a comparatively short movement of the lever.

The foundation work for the machinery in the New Haven plant deserves especial notice. Heavy stone and brick work with plenty of Portland cement is built many feet below the frost line, and for the counter-shafting piers of twice the usual breadth are built. The counter-shaft extends up to within a few inches of the open end of the station so that when the building is enlarged lengthwise the line of counter-shafting can be extended in the same manner with clutches into the new half of the building. Cohen & Brown belting is used throughout.

As mentioned there are at present in position 14 arc dynamos, to which will be added within a short time six more machines of the same size. The plant also contains a Schuyler 50-light arc machine. The company supplies at present 570 arc lights, of which 250 are to the city. The lights around "the green" near the Yale College buildings make a very striking picture. The brilliant lights cannot do otherwise than enhance the beauty of the famous "City of Elms."

## On the Absolute Dimensions of Electrical and Magnetic Units.

BY H. S. RODGERS.

The absolute dimensions of the various electric and magnetic quantities do not appear to have been given the attention that their importance deserves. Their use as a check in calculation is practiced by many, but their value as a guide to correct theory and as an aid to the better understanding of the relationships existing between the different electric and magnetic units is generally unrecognized.

This arises not so much from any inherent difficulty of the subject as from the fact that there are certain seeming inconsistencies, not always clearly accounted for, connected with the present systems, and thus what should be of the utmost simplicity becomes, to many, quite confusing.

The selection of fundamental conceptions upon which to base a system of absolute dimensions is more or less arbitrary, and is not so much a phyiscal as a metaphysical problem. Although length, mass, and time are usually chosen as units, yet perfectly consistent systems may be derived in other ways: for example, a system in which force is a fundamental concept has been devised, and there is no reason why other physical quantities, such as energy or velocity, might not be so used.

The main effort, however, in arranging an absolute dimension system should be to obtain values which are something more than formulæ or mere mathematical equivalents. There should be obtained some idea of the actual physical nature of the quantities involved. It is here, perhaps, where the greatest objections to the present electrostatic and electromagnetic systems lie.

When the student of the subject has after some thought seen why ohmic resistance, for example, may in some cases be a velocity, he is appalled to find that in another case it becomes something entirely different, namely, the reciprocal of a velocity. Though he may then receive some enlightenment from the assurance of Professor Rücker* that there has been a failure to consider the properties of the medium, and a "suppressed dimension" is wanting somewhere, yet the fact that there still exists two distinct and almost independent systems remains a little puzzling. Prof. Oliver Lodge,† it is true, has, for several of the electromagnetic quantities, offered some rather arbitrary dimensions, which are based upon Maxwell's investigations; but the only suggestion for a perfectly general system from which, by particular assumptions, the electrostatic or electromagnetic systems could be derived appears to be that of Professor Fitzgerald,‡ who showed that by making both permeability and specific inductive capacity have the dimensions of the reciprocal of a velocity the electrostatic and electromagnetic systems become identical.

In spite of this limit the two distinct systems are still the only ones generally known, although their use involves confusion and frequently actual error. For example, the suggested length of the earth's quadrant (fortunately now supplanted by the henry) as the unit of self-induction, would have been strictly correct only for substances for which the permeability was constant, and would have been of no significance whatever when the permeability varied. The term "secohm" was not open to this objection, but a somewhat similar phrase, the "volt line,§" which has been recently offered as a unit for a number of magnetic lines of force, can in no case be found to be of consistent dimensions.

A serious inconvenience of the ordinary dimension systems is their fractional exponents, which defy interpretation and make memorizing difficult. A system which is absolutely general, and at the same time presents the dimensions of the units in such simple form as to be easily remembered, is certainly desirable. It can afford a ready means of recalling and comparing the various electric and magnetic laws, and possibly may suggest other laws yet unknown.

Many electric and magnetic quantities are defined by their mechanical properties, so hitherto they have been represented in absolute dimensions as functions of length, time and mass. It is well established that a velocity enters into electromagnetic manifestations, consequently the units of length and time are, perhaps, essential, but the advisability of the introduction of the idea of mass, when dealing with purely ethereal phenomena, may be seriously questioned.

It is quite probable that matter of some sort is involved, but it certainly does not appear to act or be acted upon in the manner in which we are accustomed to consider it. It seems, therefore, more legitimate in obtaining the absolute dimensions of electric and magnetic units to neglect all mechanical equivalents and to regard the quantities from a purely electromagnetic standpoint. The following system is thus arranged, taking as fundamental units:

$N$ = a quantity of magnetism, a number of magnetic lines of force.

$Q$ = a quantity of electricity, a number of electric lines of force.

$L$ = length.

$T$ = time.

* "Suppressed Dimensions of Physical Quantities," *Phil. Mag.*, February, 1889. This point has been since emphasized by several writers, and quite recently by Professor Kimball in THE ELECTRICAL WORLD of Jan. 24 and 30, 1891.

† Appendix to "Modern Views of Electricity."

‡ *Phil. Mag.*, April, 1889.

§ *The Electrician*, London.

Consider for a moment any closed circuit. The electromotive force will, regardless of the medium, always be proportional to the variation in unit time of the number of magnetic lines enclosed, or $E = N T^{-1}$.

The current is always proportional to $Q T^{-1}$; hence, by Ohm's law, $R = \frac{N}{Q}$; $P$, power $= E I$, becomes $N Q T^{-2}$; $W$, work $= P T^{-1} = N Q T^{-1}$; and $F$, force $= W L^{-1} = N Q L^{-} T^{-1}$.

Magnetic force or strength of field is defined as the force which acts on unit quantity, or $\mathbf{H} = F N^{-1} = Q L^{-1} T^{-1}$. Strength of an electrostatic field is defined in a similar manner, $h = F Q^{-1} = N L^{-1} T^{-1}$.

Magnetic density or number of lines per unit area, $\mathbf{B} = N L^{-2}$. Similarly, electrostatic density or electric displacement, $\sigma = Q L^{-2}$.

Permeability is defined by the ratio $\frac{\mathbf{B}}{\mathbf{H}}$; therefore $\mu = N Q^{-1} L^{-1} T$. In like manner specific inductive capacity is defined as the ratio $\frac{\sigma}{h}$ or $k = N^{-1} Q L^{-1} T$.

Inductance = ratio of $\frac{N}{I}$; therefore $\mathbf{L} = N Q^{-1} T$.

Capacity = ratio of $\frac{Q}{E}$; therefore $C = N^{-1} Q T$.

Power of a magnetic shell is equal to product of density by thickness, or $\varphi = N L^{-1}$. Similarly, electrostatic power may be written $V = Q L^{-1}$.

Flow of electric force $= h L^{2} = N L T^{-1}$.

Flow of magnetic force $= \mathbf{H} L^{2} = Q L T^{-1}$.

Magnetomotive force has the dimensions of $I$, or M. M. F. $= Q T^{-1}$. Magneto reluctance $= \frac{\text{length}}{\text{area} \times \mu}$; therefore reluctance $= N^{-1} Q T^{-1}$. Specific conductivity $= \frac{I}{\text{force} \times \text{area}} = c = Q N^{-1} L^{-1}$. Specific resistance $= \frac{1}{c}$, or $a = N Q^{-1} L$.

From the above general system an electrostatic system can be derived by making $k = 1$, or $\frac{Q}{N} = \frac{L}{T}$, whence $Q L^{-1} = N T^{-1} = E$.

In a similar manner an electromagnetic system results by placing $\mu = 1$, or $\frac{N}{Q} = \frac{L}{T}$, whence $N L^{-1} = Q T^{-1} = \text{I}$.

The three systems in tabulated form are as follows:

| Name of unit. | General system. | Electrostatic system. | Electromagnetic system. |
|---|---|---|---|
| $E$ | $N T^{-1}$ | $Q L^{-1}$ | $N T^{-1}$ |
| $I$ | $Q T^{-1}$ | $N T^{-1}$ | $N L^{-1}$ |
| $R$ | $N Q^{-1}$ | $L^{-1} T$ | $L T^{-1}$ |
| $P$ | $N Q T^{-2}$ | $Q^{2} L^{-1} T^{-1}$ | $N^{2} L^{-1} T^{-1}$ |
| $W$ | $N Q T^{-1}$ | $Q^{2} L^{-1}$ | $N^{2} L^{-1}$ |
| $F$ | $N Q L^{-1} T^{-1}$ | $Q^{2} L^{-2}$ | $N^{2} L^{-2}$ |
| $\mathbf{H}$ | $Q L^{-1} T^{-1}$ | $Q L^{-1} T^{-1}$ | $N L^{-2}$ |
| $h$ | $N L^{-1} T^{-1}$ | $Q L^{-2}$ | $N L^{-1} T^{-1}$ |
| $B$ | $N L^{-2}$ | $Q L^{-2} T$ | $N L^{-2}$ |
| $\sigma$ | $Q L^{-2}$ | $Q L^{-2}$ | $N L^{-2} T$ |
| $\mu$ | $N Q^{-1} L^{-1} T$ | $L^{-2} T^{2}$ | 0 |
| $k$ | $N^{-1} Q L^{-1} T$ | 0 | $L^{-2} T^{2}$ |
| $\mathbf{L}$ | $N Q^{-1} T$ | $L^{-1} T^{2}$ | $L$ |
| $C$ | $N^{-1} Q T$ | $L$ | $L^{-1} T^{2}$ |
| $\varphi$ | $N L^{-1}$ | $Q L^{-2} T$ | $N L^{-1}$ |
| $V$ | $Q L^{-1}$ | $Q L^{-1}$ | $N L^{-2} T$ |
| M. M. F. | $Q T^{-1}$ | $Q T^{-1}$ | $N L^{-1}$ |
| Rel. | $N^{-1} Q T^{-1}$ | $L T^{-2}$ | $L^{-1}$ |
| $h L^{2}$ | $N L T^{-1}$ | $Q$ | $N L T^{-1}$ |
| $\mathbf{H} L^{2}$ | $Q L T^{-1}$ | $Q L T^{-1}$ | $N$ |
| $a$ | $N Q^{-1} L$ | $T$ | $L^{2} T^{-1}$ |

This table will bear careful study; the absence of the usual fractional exponents is at once noticeable, and the striking analogies between the electric and the magnetic quantities are clearly shown. It may be of interest to select a few examples, as follows: Observe that

$$\frac{N}{Q} = R = \frac{E}{I} = \frac{h}{\mathbf{H}} = \frac{\mathbf{B}}{\sigma} = \frac{\varphi}{V} = \frac{\text{E. M. F.}}{\text{M. M. F.}} = \sqrt{\frac{\mu}{k}} = \sqrt{\frac{\mathbf{L}}{C}} = \mu \times \text{velocity} = \frac{1}{k \times \text{velocity}};$$

whence $\sqrt{\mu K} = L^{-1} T$.

Work or energy, $W = \mathbf{L} I^{2} = C E^{2} = N I = Q E$;

$$\mathbf{L} = E \div \frac{d I}{d T} = N I^{-1} = W I^{-2} = \mu L;$$

$$C = I \div \frac{d E}{d T} = Q E^{-1} = W E^{-2} = k L.$$

Force, $F = N^{2} L^{-2} \mu^{-1} = Q^{2} L^{-2} k^{-1} = N \mathbf{H} = Q h = E$ 1 + velocity.

In electromagnetic system $F$ varies as $I^{2}$ as exemplified by the formula for the use of the electro-dynamometer. In electrostatic system $F$ varies as $E^{2}$ as exemplified by the formula for the use of the absolute electrometer. In media where $\mu$ or $k$ is not constant, the force between two electrified bodies or two magnetic poles does not vary as the inverse square of the intervening distance but as the expression $N Q^{-1} L^{-1} T^{-1}$.

In electromagnetic system $\varphi = I$, which is simply Ampère's theorem.

When $\mu$ is constant, $N = I L$ (ampère-turns); but if $\mu$ is variable, $N = 1\ \mathbf{L}$. Similarly when $k$ is constant, $Q = E L$; but if $K$ is variable, $Q = E C \frac{\mathbf{L}}{R} = T$, the time constant of the circuit. Also the inverse of frequency and $\sqrt{\mathbf{L} C} = T$.

It will be noticed that reluctance is not quite analogous to ohmic resistance and impedance; this is due to the fact that when we apply the law of the magnetic circuit we usually desire, not $N T^{-1}$, the analogue of the $I$ in Ohm's law, but simply $N$; hence the equation is written $N = \frac{\text{M. M. F.}}{\text{rel.}} = \frac{Q T^{-1}}{N^{-1} Q T^{-1}}$, which makes specific reluctance have the dimensions of $\frac{1}{\mu} = N^{-1} Q L T^{-1}$.

The complete analogy can be obtained by writing the law thus: $N T^{-1} = \frac{\text{M. M. F.}}{N^{-1} Q}$, or E. M. F. $= \frac{I}{\text{magnetic } \textit{resistance}}$; whence specific magnetic *resistance* $= N^{-1} Q L$ and magnetic *resistance* is the inverse of electrical resistance in dimensions.

In mechanics the value of energy is the product of a mass by the square of a velocity; so by equating the expression $M L^{2} T^{-2}$ to $Q^{2} L^{-1}$ and $N^{2} L^{-1}$ respectively, we obtain the dimensions for $Q$ and $N$ as given in the present mechanical electrostatic and electromagnetic systems. On the other hand, equating $M L^{2} T^{-2}$ to the general value $N Q T^{-1}$ gives $N Q = M L^{2} T^{-1}$, a result similar to what from the adoption of Professor Fitzgerald's suggestion, and making $\mu$ and $k$ each $= L^{-1} T$ in the mechanical systems. In this case $N = Q = M^{\frac{1}{2}} L T^{-\frac{1}{2}}$.

There are other considerations, particularly those arising from a study of the values for the ratio between a unit in the electrostatic system and the same unit in the electromagnetic system, which would indicate that $N Q^{-1}$ is an abstract number, regardless of the properties of the surrounding medium. Although this makes $N$ and $Q$ identical in dimensions, it by no means follows that they are identical physically. Our symbols have not taken in account the fact that $N$ and $Q$, as shown by Maxwell, are probably vector quantities and directed at right angles to each other.

Too much stress must not be placed, therefore, on any mathematical identity between $N$ and $A$, although it may be noticed that the results of such an assumption are not inconsistent with physical facts. $\mu$ and $k$ become $L^{-1} T$, $\mathbf{L}$ and $C$ become $T$. Resistance becomes an abstract numerical, and specific resistance becomes $L$.

It is needless to point out other laws and analogies; many are quite apparent, and more will appear after a slight study of the table. A sufficient number, it is hoped, have been cited to indicate that the relationship of the various electric and magnetic units are exhibited in a more simple and convenient form by the proposed method than by the systems now in use.

## The Relation of Insurance Companies to the Electrical Industries.

BY C. M. GODDARD.

In THE ELECTRICAL WORLD for April 18 Mr. C. E. Woods, in an article under the above heading, states several propositions to which, as the electrical representative of the New England Insurance Exchange, I would take exceptions.

The whole tendency of his article is an effort to show that the framing of rules for the safe equipment of electric installations does not properly belong to the insurance interests and does to the electrical interests: and right here he is at fault.

It has always been deemed proper that the insurance representatives should lay down the requirements for sprinkler systems, for thermostat systems and other equipments of such nature rather than that they should be put in to suit the parties who have these systems for sale: and the same reasoning will apply to electric light and power equipments, and it is certainly much more proper that these rules should be made by electricians who have *also* some experience in insurance matters than by electricians who have *only* electrical experience.

That all insurance organizations are ready and glad to have the purely electrical organizations co-operate with them is also true; and before the rules of the New England Insurance Exchange, as revised by me, were promulgated, they were submitted to and after some slight changes approved by a committee from the New England Electric Exchange appointed for that purpose.

To Mr. Woods' statement that insurance rules "contain some *musts* but more *shoulds*," I would suggest that in the rules above referred to there are 224 requirements governed by the word "must," 21 by the word "should" and 11 by the word "may." Most of the "shoulds" are like the following: "A waterproof covering should be kept over the dynamo when not running," and the "mays" are of such a nature as "Wires run in conduit tubing may be laid side by side, and the tubes may be fastened by metallic loops." As to the enforcing of these rules, possibly the parties doing work in New England may differ from Mr. Woods in his ideas on this point, and he certainly shows that he does not appreciate the points of most importance when he says, "Insufficient capacity of wires is the chief danger, as that means hot wires." Insufficient capacity is one of the least important points. I have, in all my experience, both in construction work and also as inspector for the New England Insurance Exchange, never found a case of fire from the overheating of wire on account of its size. That is a point that takes care of itself, for in all ordinary installations if the wire is too small for safe carrying capacity the "drop" will be so great that it becomes immediately noticeable in lights being much below candle power, etc.

Mr. Woods states that the insurance inspector's "greatest demand is for better insulation, and yet he never tests

it." Here again he is in error, for by what follows he shows that by "insulation" he means the *insulating covering of the wire*, and yet by reference to our rules he will find that very little is said on this point. It is the *insulation of the whole installation* that we look to, and we provide for this in two ways--either by giving the wire an air insulation (than which there is none better) or by inclosing the wires in a system of waterproof insulating tubing. Either of the above ways can be inspected very satisfactorily by the *eye* without an elaborate series of tests, which in our work cannot be given to each risk.

As to the discriminating against high-tension currents the only point of discrimination is that high-tension wires are not allowed to be concealed in any way.

Mr. Woods' suggestion of State laws must carry with it State supervision and inspection, and this is the first time I ever knew any class of industry to ask for State supervision. Possibly he is so enamored of the work of the State Board of Electrical Control in connection with the subway work in New York City that he wishes to see it duplicated all over the country.

Mr. Woods states that it falls within the province of the National Electric Light Association to formulate rules, etc., but possibly the insurance interests may feel it also falls within their province to state what they will accept and what they will reject.

The matter of examinations and licenses has probably been better tested in New England than anywhere else, and while it may decide who is competent to do good work it has so far failed to guarantee that the competent man *will* do good, safe work.

In view of the well-known friendly relations that exist between the New England Insurance Exchange and the New England Electric Exchange and all the electrical interests in our territory it is unnecessary for me to say that we are glad to have the electrical interests co-operate with us; that we endeavor to impose the fewest possible restrictions on the introduction of electricity, even granting reduction of premium in certain cases where the exclusive use of electric light is guaranteed; that if the National Electric Light Association will formulate rules suitable for our use we would undoubtedly adopt them; that we are heartily in accord with Mr. Woods in his endeavor to awaken the electrical interests to the importance of this question; and that we hope they will take it up intelligently. But we must also say that we think the reasons he presents for the necessity of action by the electrical interests are faulty, and that his strictures upon the existing state of affairs show unfamiliarity with the subject.

## The Separation of Foucault and Hysteresis Losses.*

BY GISBERT KAPP.

The total loss of power taking place in the armature of a continuous current dynamo beyond the unavoidable loss due to copper resistance is made up of the following:

(*a*) Loss through mechanical friction.

(*b*) Loss through hysteresis in the armature core.

(*c*) Loss through Foucault currents, either in the armature core or in all the conductors, or in the conductors under commutation only, if the setting of the brushes is faulty.

A further loss of power is due to air resistance, but this is so insignificant that it may be neglected.

It need hardly be pointed out that any simple method by which we can separately determine these losses is of practical value, and I propose to describe such a method in the hope that some reader may find a way to further develop it, so as to become applicable to alternators and transformers, a class of apparatus in which the exact determination of Foucault and hysteresis losses is of even greater importance than it is in continuous current dynamos.

The method is based upon the supposition that the torque required to overcome hysteresis and mechanical friction is independent of the speed, and that, therefore, the work lost through these two causes (if the field strength remains constant) is simply proportional to the speed. Since both mechanical friction and hysteresis are assumed to follow the same law, it is clear that a method based on such an assumption cannot be used to separate these two losses, but can only give their sum. The loss by friction can, however, be determined with a fair degree of accuracy from the dimensions of the bearings, weights, magnetic attraction, speed, the lubrications, etc., and thus we can, at least approximately, get the hysteresis alone, provided we can separate the Foucault losses. It should also be remembered that the purely mechanical loss by friction is generally very small as compared with the other two losses, and an error in the estimate of the friction has only a small effect on the correct determination of the hysteresis loss, and no effect whatever on the determination of Foucault losses.

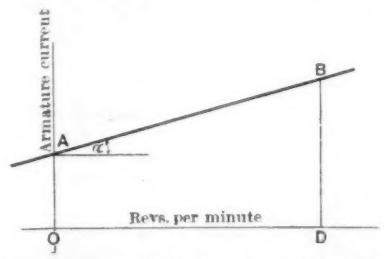
For the same excitation the Foucault losses must obviously increase as the square of the speed. We have, therefore, the following equation for the total number of watts wasted in the armature, other than by copper resistance:

$$W = n\,H + n^2\,F,$$

$n$ being the speed in revolutions per minute, and $H$ and $F$ coefficients which depend upon the excitation, but do not vary with the speed. The coefficient $H$ refers to the loss due to hysteresis and friction, and the coefficient $F$ refers to the loss due to Foucault currents.

Mr. W. Mordey was probably the first to make use of this equation in order to determine and separate the various losses which occur in the armature. His method is as follows: He drives the armatures by means of a belt from an electromotor, and notes either the electrical power supplied to the motor, or by means of a transmission dynamometer the mechanical power given to the armature with its field inert, and also with its field excited to various degrees. Provided the transmission dynamometer is correctly calibrated, or the efficiency of the motor is accurately known for these various conditions, and the loss of power in the belt is also known, this method can be used to separate not only Foucault losses from losses due to hysteresis and friction, but also the initial friction loss when the armature is revolving in a non-excited field from the hysteresis and friction loss when the armature is revolving in an excited field. Keeping the excitation constant, Mr. Mordey varies the power supplied to the armature under test, and thus gets a series of values for $W$ and $n$, which are plotted in a curve. Selecting any two points on this curve (not too near each other) it is easy by a trial and an error method, or by the solution of a quadratic equation, to determine the values of $H$ and $F$ which will satisfy this curve throughout its range, and having found these values, the above equation enables us at once to separately determine the losses.

There are, however, some objections to this method. In the first place, it pre-supposes the possession of a reliable transmission dynamometer or an exact knowledge of the efficiency of the motor and of the loss of power in the belt, both points on which legitimate doubts may be entertained. In the second place, and this is the more serious objection, the necessity of using a second machine as a motor and rigging up a belt transmission involves an amount of labor and expense which one would be glad to avoid. In the new method no second machine is required, but it has the disadvantage of being only applicable to armatures which have already received their winding;




CURVE REPRESENTING CURRENT AS A FUNCTION OF THE SPEED.

whereas Mr. Mordey's method can be used to investigate an armature core before it is wound. The method about to be described is also based on the above formula, but the power $W$ is supplied to the armature under test electrically instead of mechanically; in other words, the dynamo to be tested is run light as a motor, and note is taken of the speed and armature current while the excitation is kept constant. At least one reading of the pressure at the brushes (preferably at the highest speed and armature current) must also be taken, but more such readings may be taken as a check. Since the dynamo is running light, the armature reaction on the field will be small enough to allow us to neglect it, or, in other words, we are justified in assuming that the field strength remains constant for all speeds. It should, however, be remembered that this is only an approximation, and that the Foucault currents, if they are very strong, will produce a distortion of the field, quite apart from the very small distortion produced by the armature current proper. In fairly good machines such a result need, of course, not be expected.

Assuming, then, a constant field of $z$ (English) lines, and denoting by $r$ the number of external armature conductors in a two-pole machine, we have the E. M. F. at the brushes given by

$$e = z\,r\,n\,10^{-8}$$

if we neglect the very small E. M. F. lost in armature resistance. The power supplied by the current $c$ is

$$W = e\,c,$$

or

$$c\,z\,r\,n\,10^{-8} = n\,H + n^2\,F,$$

from which it follows that

$$c\,z\,r\,10^{-8} = H + n\,F.$$

Since $z$ and $r$ are constant, the current is equal to the sum of a constant, $\frac{H}{z\,r\,10^{-8}}$ and another factor, which varies directly with the speed. The curve representing the current as a function of the speed must, therefore, be a straight line, as shown in the annexed diagram. The height $O\,A$ at which this line intersects the vertical axis is a measure of the current required to overcome the torque of friction and hysteresis, and the inclination of the line is a measure of the influence of Foucault currents, or in symbols

$$\tan a = \frac{F}{z\,r\,10^{-8}}.$$

Let $c_0 = 0\,A$ be the initial current, then we find directly from the diagram the value of the coefficient $H = c_0\,z\,r\,10^8$, and inserting this in the formula given above, the value of

$$F = \frac{W - n\,H}{n^2},$$

where $n$ and $w$ are observed values. It should be noted that in practice it is not even necessary to know the winding and field strength. All we need do is to observe the current and speed in order to determine the position of the straight line $A\,B$, and take an accurate reading of the pressure $e$ and current $c = D\,B$ observed at a particular speed $O\,D$. The ratio $c_0/c$ at once gives the ratio of loss due to hysteresis and friction to the total loss which includes the Foucault losses, and since we know the total loss ($w = c\,e$) its two component parts can be found by a simple rule of three and a subtraction. If the current curve $A\,B$ is not a straight line it is a sign that the Foucault currents are strong enough to produce a distortion of the field.

From *The Electrician*, London.

## Notes on the Design of Multipolar Dynamos.*

BY W. B. ESSON.

Though comparisons have frequently been made of the capabilities of machines having two poles and those having a greater number, I am not aware that the design of multipolar dynamos has yet received systematic treatment in any communication, or that a very satisfactory basis for comparison of the two types has up to the present been suggested. A perusal of the notes scattered about in technical journals, proceedings of societies and text-books shows that the ideas of this subject are of the vaguest character, their expression having a most uncertain tone, and generally manifesting some erroneous notion. It is with a view of clearing the ground a little, and inducing some expression of correct ideas from members present, that these notes are brought before the institution.

I. PREVENTION OF SPARKING IN MACHINES GENERALLY.

In the paper which I submitted for your consideration 12 months ago, attention was directed to certain empirical formulæ relating to the armature loads for direct current machines. From the data furnished by a large number of examples, some of which were given in the paper, an expression for the load which could be safely carried by armatures without causing sparking was obtained; this expression, though admittedly of an arbitrary character, having been proved by my own experience and that of my colleagues to have been of some service. In that paper the term "ampère turns" was employed to denote the product of the number of conductors on the exterior of the armature and the current carried by each, and I am afraid this may have led to some confusion; at least so it appears from the discussion. In order that there shall be no misunderstanding in the present case, I shall call this product, quite irrespectively of the number of poles, the *volume* of current carried. The volume is therefore the total current flowing parallel to the armature shaft, independently of direction and whatever the number of poles, and it is obtained by multiplying the conductors on the exterior of the armature by the current flowing in each; or, considering the exterior winding as a copper cylinder, it is the total current flowing in it parallel to the axis.

In his paper on "Armature Reactions," read here last year, Mr. Swinburne had worked out the limiting load from a theoretical point of view, and those who were present will remember that to obtain the results given in his paper the author assumed that the brushes were placed quite close to the polar tips. So far as the practical consideration of the subject goes, it matters little, I think, whether this is strictly accurate or not; because, while moving the brushes back from the tips increases the ampère turns producing the cross field, the magnetic resistance of the cross circuit is at the same time increased, due to the interposition of an increased air gap. For the moment, however, it will be assumed that the brushes are somewhere near the pole tips—in their vicinity, let us say—and that the only conductors concerned in producing the cross field are those covered by the pole pieces. This is sufficiently near the truth for our purpose. Under these circumstances the magnetizing force in ampère turns producing a cross field is, of course, $\frac{v\,\varphi}{360}$, where $v$ is the volume, and $\varphi$ the angle embraced by each pole piece in degrees. Call $l$ the length of the air gap, measured from the surface of the armature core to the polar surface, and $I$ the induction per square centimetre which would be produced in the gap due to the field magnets alone. When a current flows in the armature the field is weakened at the pole tips nearer the brushes, and strengthened at those farther from them. Imagine that the armature is loaded so that the forward induction under the nearer pole tips is just balanced by the cross induction and we have $\frac{v\,\varphi}{360} = 2\,l \times .8\,I$, assuming that the components of the cross circuit, other than the air gap, have no resistance. According to this equation, with a value $v = \frac{576\,l\,I}{\varphi}$,† the forward and cross induction at the

*A paper read before the Institution of Electrical Engineers, London, April 9, 1891.

†I have pointed out to Mr. Swinburne that the equations $A = \frac{10\,b\,g\,Ba}{\delta^2\,r}$ and $A_2 = \frac{10\,Ba\,r\,R\,l}{w^2}$ which he gave last year on p. 266 of his reply ought to be $A = \frac{5\,b\,g\,Ba}{\delta^2\,r}$ and $A_2 = \frac{20\,Ba\,r\,R\,l}{w^2}$ respectively. In looking over his paper and reply Mr. Swinburne finds other slips which he will probably correct as discussion on the present paper proceeds.—W. B. E.

pole tips would be equal, the field would be *nil* at the brushes, and, the machine being unstable, any increase of current would at once cause great sparking.

The above expression gives what might be called the theoretical load limit, on the assumption that no field is required for reversing the current in the sections as they pass the brushes, but it need scarcely be pointed out that in practice the volume is always much under what would be given by the formula. In the nature of things, one expects in the dynamos of different makers a considerable variation in the relation which the actual load bears to the limit above indicated, and such differences undoubtedly exist; but while one finds, on examining a large number of machines, several under, in few cases are there any having for $v$ a greater value than half that given by the equation. This large margin must be considered in the light of a safety factor, for it would be folly to build machines the commutators of which would be liable to ruin by an occasional increase of current over the normal. No one expects machines to stand, in continuous working, a current of 50 per cent. over their normal output, for the rise in temperature would then be excessive; but, from the sparking point of view, this increase in a well-designed machine ought to make but little difference to it. Generally, the relation existing between the volume, gap dimensions and induction in the best machines is expressed approximately by the equation,

$$v = \frac{288\ l\ I}{\varphi} \qquad (1)$$

which gives, I consider, a very good rule for use in practical work. According to this, the working volume has about half the value expressing the absolute limit, this relation indicating the margin of safe working dictated by practice and experience. The formula expresses, in fact, an empirical relation which has a certain degree of flexibility. But with such a large margin it will be readily perceived that the strict accuracy of our assumption about the position of the brushes is of trifling importance, as is also our assuming that the whole of the magnetizing force of the cross field is spent in the air gap.

It is easy to translate the above expression into the form I previously used for cylinder armatures. Call $r$ the radial depth of the armature core, $w$ the width of the pole piece, and $I_g$ the induction in the core. The induction, $I$, in the gap is $\frac{2\,r\,I_g}{w}$; and substituting for $I$ its value, we have

$$v = \frac{576\ r\ I_g\ l}{w\ \varphi} \qquad (2)$$

Taking the induction in the armature core at from 17,000 to 18,000 C. G. S. per square centimetre, and inserting an average value of $\varphi$, we get for bi-polar Gramme wound machines the expression,

$$v = \frac{r\ l\ 85{,}000}{w} \qquad (3)$$

which I had used for some time, which was given in my last year's paper. This is only a rough approximation, for, as Mr. Swinburne has pointed out, to be quite accurate, the angle should appear in the denominator as in (1) and (2). The simplest form the expression can take is given in (1). This contains nothing but the length of the air gap, the induction in it, and the angle of the pole piece. It will be observed that it takes no notice of the diameter of the armature or of the number of poles. So far as the sparking limit is concerned, it gives a rule which may be employed in designing machines of any size and with any number of poles.

### 2.—THE RELATION OF $v$ TO THE DIAMETER OF THE ARMATURE.

But besides taking care that the armature load does not approach the sparking limit, we must provide ample surface for getting rid of the heat generated in the conductors. The first thing to be settled in designing a new machine is what this amount of heat shall be; or, in other words, we must fix the ratio which the energy appearing at the terminals shall bear to the total electrical energy produced. Having settled this, sufficient radiating surface must be allowed to prevent too great a rise in temperature—a point to which due consideration has already been given.

The principal factors which determine the relation of the volume to the diameter of the armature are efficiency and temperature. It will be seen that the equation (1) gives no direct information respecting the diameter for a given volume, and as long as $I$, $l$ and $\varphi$ remain unchanged, the tendency to sparking would be the same whatever the diameter. But it is not so with the heat generated or the temperature rise, for assuming $v$ and $l$ to be related as shown, the smaller the diameter the greater would be the temperature. To carry a given volume we must have, consistent with the waste of power permissible, a certain section of copper; and this copper should be disposed so that a cooling surface is provided sufficient to keep the rise in temperature within the specified limit, while the gap, being of sufficient length to prevent sparking, should have only the dimensions necessary for accommodating the conductors and allowing of proper clearance.

Through the kindness of members of the institution and others, who have liberally supplied me with figures, I have been able to ascertain the nature of the relation between the diameter and volume existing in all the best known machines, from the smallest to the largest sizes. The figures refer to both cylinder and drum-wound armatures, and include machines with two, four, six, and eight poles. Though I am not at liberty to publish the data in full, th general results are given. There is not so much agreement between the dynamos of different makers in respect to this relation as might have been expected, and for $v$ we have all kinds of values, ranging from 200 to 1,000 times the diameter of the armature in centimetres. If full advantage of the length of the air gap were taken, and the thickest possible conductor used in each case, the diameter, to give a uniform temperature for all sizes, would be about proportional to the square root of the volume, but there are several reasons why this proportion should not obtain in practice. With this relation the ratio of the stray to the useful field would increase with the diameter, thus entailing an extravagant expenditure of energy in producing the requisite gap induction. Again, while the total field through the armature would increase simply as the diameter, the volume carried would increase

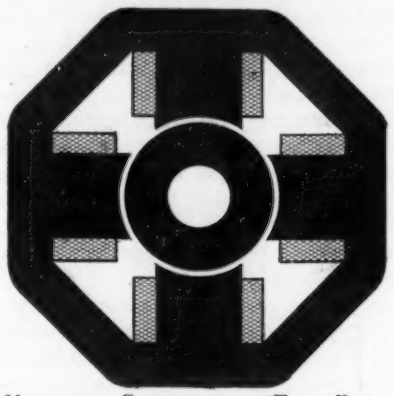


Fig. 1.—Magnetic System of a Four-Pole Direct Current Machine.

as the *square* of the diameter, this being at variance with the well-established rule that the total field through the armature increases rather than diminishes relatively to the volume as the size is increased. It will be understood, of course, that precisely the same result is arrived at whether we consider the volume fixed and endeavor to find the best diameter, or consider the diameter fixed and seek for the best volume. It is simply a question of obtaining the most economical construction, having regard to cost of materials, efficiency, prevention of sparking, and temperature limit, though the figures at my disposal show estimates of the relative values of these factors to be by no means uniform.

Though the relation lacks definiteness to some extent, I find in the data of a large number of machines indications sufficiently pronounced to justify us in regarding the volume carried by the armatures of two-pole dynamos as proportional to the diameter for all sizes. In designing cylinder machines the value of $v$ may be taken as 400 times the diameter of the armature in centimetres, while for drum armatures the volume is obtained by multiplying the diameter by 600.* The cylinder armature has for a given volume a larger diameter, because of the influence of the interior wires. These being heaped inside to one and a half or twice the depth of the exterior winding, also being longer, a larger diameter is required for a given volume, both from efficiency and temperature considerations. Necessarily, the relations here given are not of a hard-and-fast character, and may be varied considerably. But whatever the proportion adopted, it is absolutely essential that the spark-

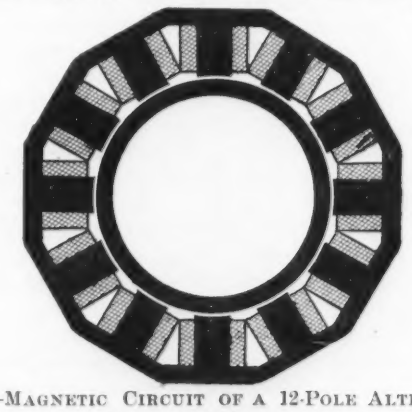


Fig. 2.—Magnetic Circuit of a 12-Pole Alternating Current Machine.

ing limit already considered be not too closely approached.

In machines having four and six poles the same average relation between the volume and diameter holds in practice for both cylinders and drums. In the calculations which follow these figures will therefore be adopted.

### 3.—OUTPUT OF DIRECT CURRENT ARMATURES.

If we call $N$ the total number of lines of force entering the armature from all the poles, however many, and $n$ the number of revolutions per second, the average E. M. F. generated in each conductor is, of course, $N\,n\,10^{-8}$. If $C$ be the total current flowing, each conductor will carry with the sections coupled in the ordinary way $\frac{C}{p}$ ampères, $p$ being the number of poles. The electrical work done to each conductor, is $\frac{C}{p} \times \frac{N\,n}{10^8}$; and the total work, $\frac{w\,C}{p} \times \frac{N\,n}{10^8}$, where $w$ is the number of conductors, counted all round the exterior of the armature. The quantity $\frac{w\,C}{p}$ is what we have called the *volume*, and we get for the total electrical output in watts the expression,

$$W = N\,n\,v\,10^{-8} \qquad (4)$$

which is quite independent of the manner of coupling up the armature sections. It will be evident, I think, that with the same relation existing between $v$ and $d$ for two, four and six poles, the output of an armature of given diameter and length running at the same speed is quite independent of the number of poles. It matters not whether $N$ be furnished by two poles only, or by four poles of half the angular width provided its value remains unaltered.

The volume then may be expressed in terms of the diameter. The quantity $N$ may be expressed in terms of the diameter × length of the armature. Taking an induction of 5,000 C. G. S. units per square centimetre in the air gap, a very usual figure, and assuming that the fraction of the armature circumference covered by the pole pieces $= 2.25\,d$, we get, calling $L$ the length of the armature in centimetres, $11{,}250\,d\,L$ as the total number of lines of force entering the core. Call this, in round numbers, $12{,}000\,d\,L$. Substituting for $N$ and $v$ their values, the output becomes for cylinder armatures.

$$W = .048\,d^2\,L\,n \qquad (5)$$

and for drum armatures

$$W = .072\,d^2\,L\,n \qquad (6)$$

This applies to all direct-current machines, whether bipolar or multipolar; though it will be understood, of course, that the induction in the gap may be greater or less than what has been assumed. In that case the coefficients .048 and .072 would be altered, without changing, however, the form of the expression.

### 4. OUTPUT OF ALTERNATING-CURRENT ARMATURES.

The armature loads for alternators, though producing a cross magnetization, as in direct-current machines, raise no considerations, of course, as regards sparking. But on account of the greater proximity of the poles, and the greater stray field resulting, it is desirable to make the layer of copper on the armature core as thin, and the air gaps as short, as possible. As a consequence, probably, of the increased ratio of stray to useful field, the induction is less in the gaps of alternating than in those of direct-current machines. Here it will be assumed that the virtual induction is 4,000 C. G. S. units per square centimetre, meaning that this represents the induction to which the resultant E. M. F. is due. The impressed E. M. F. is greater than the resultant, and the induction due to the field magnets alone is greater than 4,000; but what I am dealing with is the field resulting from the interaction of the magnet and armature fields: it is the field to which the resultant E. M. F. $= C\,R$ is due, this and the current being coincident in phase. Usually the poles cover a fraction of the circumference $= 1.5\,d$, the value of $N$ for alternators being then $6{,}000\,d\,L$. About half the circumference being covered with wire, under usual conditions of temperature and efficiency we have for $v$ a mean value of 400, which gives for the product of mean resultant E. M. F. and mean current $= .024\,d^2\,L\,n$. In some cases, as in the Westinghouse machine, the conductors cover considerably more than half the circumference, and $v$ is therefore greater. But here, on account of the differential effect produced on the separate wires of the same section, the added turns have nothing like a proportionally increased value, and the expression will give approximately the value of the product of mean resultant E. M. F. and mean current, even in these machines. Assuming that the E. M. F. is a sine function of the time, to get the watts we must multiply by $\frac{\pi^2}{8}$, which gives us, therefore, as the output of the alternator

$$W = .0296\,d^2\,L\,n \qquad (7)$$

or rather over 40 per cent. of the work done by a drum wound direct current machine having an armature of the same external dimensions. Some comparisons have been made of the output of direct and alternating machines of the same weight, but these, in the nature of things, must be misleading. The two types are quite unlike in their proportions, as Figs. 1 and 2 show, and no one would think of making them the same. Fig. 1 represents the magnetic system of a four-pole direct, and Fig. 2 that of a 12-pole alternating machine, of the same output; and while it will be observed that the iron parts—core and yoke rings—are much heavier in the former, it will be noticed that the copper in the magnet coils is much heavier in the latter. In fact, though the iron in the alternator is only 55 per cent. of that in the direct current machine the copper required is no less than 150 per cent. It is difficult, then, to understand what useful purpose is served by comparisons such as I have alluded to.

*(To be continued.)*

* In my last paper the number given was 570. This I now amend as above.—W. B. E.

## The Wave Lengths of Electrical Oscillations.

In repeating the experiments of Hertz upon the wave lengths of electrical oscillations, H. K. Waitz has arrived at the following conclusions, namely: (*a*) A discharge of an induction coil of a definite species excites oscillation of different wave length, which may extend over an interval of many octaves; (*b*) among these electrical oscillations there is one of greater intensity, the wave length of which is determined by the dimensions of the conductors; (*c*) the electrical oscillations in or upon conductors change their wave lengths when the medium surrounding the conductor changes.

## The Magnetic Circuit of Transformers: Closed Versus Open.*

BY S. EVERSHED.

(48) Let us examine this a little more closely. Imagine a bar magnet to be thrust into a conducting ring, causing eddy currents in it. In Fig. 14 the law by which the induction threading the ring varies with the time as we push the magnet in is indicated by two curves, either of which if represented by the equation,

$$\mathbf{B}_t = \frac{\beta}{T}t + \frac{\mathbf{B}' - \beta}{T}t^2,$$

where $\frac{\beta}{T}$ is the tangent of the angle made by the tangent to the curve at $t = 0$; and $\beta$ is obviously the value $\mathbf{B}$ would have when $t = T$, provided the induction continued to increase at its initial rate from 0 to $T$. The curve is convex or concave to 0 $T$, according as $\beta$ is less or greater than $\mathbf{B}'$, and when $\beta = \mathbf{B}'$ it becomes a straight line. We can vary the rate at which we push the magnet into the ring in any way we please, and so make $\mathbf{B}$ increase according to any law, and the problem being to determine which law will make the energy wasted in currents in the ring a minimum, we start by choosing an equation which practically represents any regular law. The electromotive force in the ring during the motion of the magnet is $\frac{d\mathbf{B}}{dt} = \dot{\mathbf{B}}$; the resistance of the ring being $r$, the irreversible work done by pushing the magnet into it—the work turned into heat through the medium of electric currents in the ring—is

$$W = \int_0^T \frac{\dot{\mathbf{B}}^2}{r}\, dt,$$

and, if the value of $\mathbf{B}$ is obtained from the equation just given for $\mathbf{B}_t$, and the integration performed, we arrive at the following value for the work done:

$$W = \frac{1}{rT}\left\{ \mathbf{B}'^2 + \frac{1}{3}\left(\beta - \mathbf{B}'\right)^2 \right\}.$$

Now, as $(\beta - \mathbf{B}')^2$ is always positive whatever value is chosen for $\beta$, it is clear that $W$ is a minimum when $\beta = \mathbf{B}'$; the second term then vanishes, and the minimum work done is

$$W = \frac{\mathbf{B}'^2}{rT};$$

and this is evidently when the law of increase of induction is

$$\mathbf{B}_t = \frac{\beta}{T}t = \frac{\mathbf{B}'}{T}t.$$

that is to say, when the rate of change of induction is constant; a result entirely in accordance with our sense of the fitness of things. To push the magnet in in *no* time would only end in melting the ring, and would require an infinite amount of work.

(49) Other things being the same, then, the eddy current waste in a transformer, and generally in all parts of an alternate current apparatus, will have the least possible value when the *induction* follows a zigzag law. Fortunately, large eddy current waste is usually so easily avoided by judicious lamination of conductors, cores, and other conducting parts of alternate current machinery, that there is no occasion to attempt the realization of any alternator giving E. M. F. waves of the shape assumed in Fig. 12. The

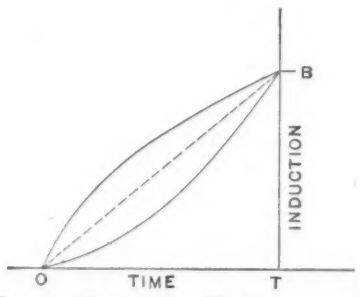



FIG. 14.—THREE MODES OF RAISING THE INDUCTION THREADING A CIRCUIT TO VALUE $\mathbf{B}$ IN TIME $T$, THAT INDICATED BY THE DOTTED LINE WASTES LEAST POWER IN EDDY CURRENTS.

point was worth notice, however. In most transformers the loss from hysteresis is so much larger than that arising from eddy currents that there is a distinct gain in efficiency when the impressed E. M. F. follows a zigzag law, and the alternators would run at a slightly lower speed, so that, in spite of the dictum of a well-known professor, to the effect that "if an alternator does not give a sine curve it must be *made* to do so," the fact remains that there is a very small balance of advantages in favor of the zigzag wave. It is obvious that the one essential condition for general efficiency of an alternate-current system is that the induction should be always *changing*; if it is constant during any fraction of the period, that fraction of time is wasted. So long as this condition is fulfilled the actual shape of the E. M. F. and current waves is of practically no importance.

(50) The broad lesson to be learned from the diagrams Figs. 10, 11 and 12 is that in studying the losses in the cores of transformers we may neglect the slight differences due to widely differing E. M. F. wave forms; so that such diagrams may be drawn according to any simple method involving little labor. The zig-zag and the sine diagrams are about equally easy to work out, each being slightly more laborious than the alternating constant $E$ diagram. As nearly all alternators gives wave forms

* Continued from THE ELECTRICAL WORLD, April 25, 1891.

something between a zig-zag and a sine function, preference must be given to them, and in drawing a diagram for No. 2 as an open transformer we shall choose the latter, but before doing so it will be best to make the modification alluded to in the note on page 290. It appears from the corrected figures for the dimensions and exciting currents for "hedgehog" transformers that the total effective surface of the spherically spread wires of the core is considerably greater than our original estimate, and the exciting current correspondingly less—a fact which will be further discussed when comparing the results of our more or less theoretical investigation with actual results of observation.

(51) In actual work No. 2, Fig. 8, would require about .7 ampère to excite it, so that the daily waste as $C^2R$ for exciting current would be $7.6 \times 7 \times 24 = 90$ watt hours nearly, instead of 182, as previously calculated; but the core waste was 2,470 watt hours per diem, so that it would

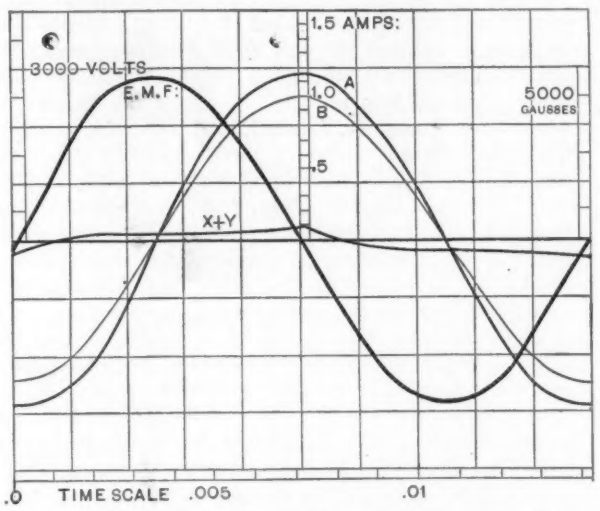



FIG. 16.—NO. 2 AS AN OPEN TRANSFORMER WITH SMALL HEDGEHOG ENDS (FIG. 15) RUN BY A SINE E. M. F.

$X + Y$ = Total exciting current required by the core; $A$ = Exciting current required by the air path; $\mathbf{B}$ = Induction density in the core; $F = 700$; output = 0; $E = 2{,}000$ volts.

evidently pay to cut down the spherical ends and save on the larger loss. If the total length of the core is reduced from 93 to 74 centimetres, the volume being proportionately diminished, the waste of power in the core becomes 82.3 watts; the exciting current will be about .9 ampère, and the efficiency on the six hours' load at 4,000 watts is as follows:

TABLE XV.—NO. 2 AS AN OPEN TRANSFORMER WITH SMALL "HEDGEHOG" ENDS.

Maximum $\mathbf{B} = 5{,}000$. $F = 70$.

Load as in Table V.

| | | |
|---|---|---|
| Total output | 24,000 | watt hours. |
| 24 hours' waste in core at 82.3 | 1,975 | " " |
| 24 hours' waste $Cp^2 Rp$ for exciting current | 148 | " " |
| 6 hours' waste $C^2 R$ for load | 372 | " " |
| | 26,495 | " " |

$$\text{Efficiency} = \frac{24}{26.5} = 90.5 \text{ per cent.}$$

Resistance drop = 2.8 per cent. at full load.

(52) The diagram given in Fig. 16 is obtained in exactly the same way as was explained in connection with the closed transformers, but it is convenient, in dealing with open transformers, to divide the magnetizing current in two portions, one being that required for the core alone, including anti-eddy current, the other being that required to magnetize the air-path from pole to pole. The total maximum induction being 5,000 × area of core, and the so-called magnetic resistance of the air-path being approximately calculated, the necessary air magnetizing component of the exciting current is easily ascertained and plotted in. It is, of course, co-phasal with the induction, and therefore exactly a quarter period behind the counter E. M. F. The exciting current for the core is calculated and plotted just as in the case of the closed transformer, the same $\mathbf{B}$ $\mathbf{H}$ curve (Fig. 9) being used, and indeed the only change made is in the length of core, which is now 74 centimetres as against 147 centimetres for No. 2 closed transformer. In Fig. 16 the hysteresis and eddy current, $X$ and $Y$ components, are added before plotting in order to prevent confusion. The scale to which current is plotted in Fig. 16 is one-fourth that used in the previous diagrams.

(53) As has been noticed above, the exciting current for the air-path is exactly a quarter period behind the counter E. M. F. It is, therefore, very nearly $\frac{1}{4}T$ behind the impressed $E$; it would be exactly so but for the resistance of the primary coil, which leads to a little potential difference between its ends being required to maintain the exciting current in it. But the maximum value of $CR$ is only $7.6 \times 1.26 = 9.6$ volts, and this is entirely negligible compared with the maximum counter $E$—2,860 volts—so that the latter must be almost precisely in step with the impressed $E$. For every practical purpose the air-exciting current may be treated as being exactly $\frac{1}{4}T$ behind the impressed $E$, and consequently, though "full of sound and fury," it signifies next to nothing, when reckoned as waste of power. It is, apparently, for this reason Mr. Swinburne speaks of it a

"spurious" current. This is a needless epithet, for, after all, it is a real current, and it will be preferable to speak of a current which is $\frac{1}{4}T$ out of step from $E$ as an *idle* current—a current, that is, which does no work and requires no power to maintain it beyond that wasted in heating the conductors. We have already noticed that the one defect introduced when transformer No. 2 was converted into a "hedgehog" was the large exciting current. It is now clearly established that a very large proportion of the whole of the exciting current is idle. The additional efficiency of an open circuit transformer costs nothing—less than nothing, for the material used is somewhat less, and the labor would also be diminished to some extent. But there is a useless encumbrance given away with the bargain, namely a large idle current, which may quite conceivably lead to a new metamorphosis. A supply company, after putting in highly efficient open circuit transformers over the whole of its system, might discover that it was harboring white elephants disguised as "hedgehogs."

(54) Compare two generating stations, one supplying through "closed," the other through "open," transformers. For each 10 h. p. converter on the circuits, the "closed" system will have to supply two ampères as load plus .11 for exciting during the assumed six hours of heavy load, while during the daytime probably .5 ampère for load plus the exciting current will be required, so that the ratio of heavy load to light load is about $\frac{.61}{2.11} = .29$, and this is nearly enough the ratio of the plant in use. Under the same conditions the heaviest output of the "open-transformer" station will be two ampères useful load plus .9 ampère exciting current, and .5 plus .9 ampère on the light load, a ratio of $\frac{1.4}{2.9} = .48$, so that the closed system will run 29 per cent. of its plant during light load, as against 48 per cent. with open transformers. Recollect that this does not mean 29 and 48 per cent. of the *power*—the open-circuit transformers will be wasting less than half the power lost in the cores of their closed rivals. What it does mean is that the current capacity of the alternators at light load must be 29 and 48 per cent. of heavy load for the closed and open systems respectively, so that the latter system will necessitate the running of large engines and dynamos during 16 or 20 hours a day at a fraction of their normal load, and therefore giving a very low all-round efficiency. In short, the coal wasted in running engines at a small load will cut down the saving effected in the open transformers, leaving only a balance, and that balance not by any means necessarily on the right side. This is a point on which there is really no evidence one way or another, no accurate analysis of alternate-current station running expenses having yet been published.

(55) It may be taken for granted that a station supplying through open transformers would be seriously hampered by the large idle current for exciting, just as many—perhaps all—closed transformer systems are now saddled with the inordinate waste of power in the cores. Station

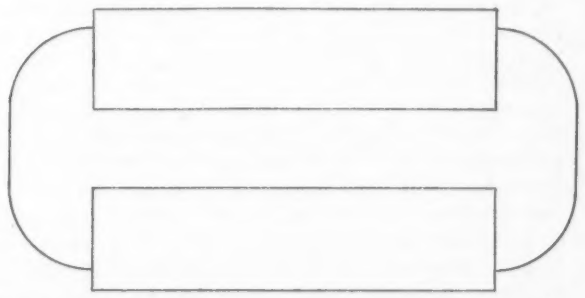


FIG. 15.—NO. 2 AS AN OPEN TRANSFORMER, WITH SMALL HEDGEHOG ENDS. ONE-TENTH FULL SIZE.

managers were once told that they need take no notice of the primary current on light load; it had a lag of ever so many degrees, so it meant nothing at all practically as power; but at least one manager knew and had the courage to declare that the coal bill told a very different tale, that the product of volts and ampères hardly required multiplying by the cosine of the lag to make it tally with the coal consumption. We know definitely now what was only vaguely suspected a few years ago; we know what all the power went for—core hysteresis and eddy currents. We have learned how to eliminate the latter by reducing the thickness of the core plates; their width is of insignificant importance. It would be rash to say that we can never hope to save the entire waste due to hysteresis, but it appears at present to be impossible to do so, except by throwing away the whole of the iron core. And when that is either wholly or partially done a new difficulty and new loss arise in the shape of idle current. But, while it may be really impossible to produce changing induction in iron without hysteresis loss, it is certainly quite possible to produce large idle currents without using large alternators; so that there is still some hope of our ultimately being independent of hysteresis. The ground for that hope will be seen in a future article.

*(To be continued.)*

## Electricity in the Production of Aluminium.*

BY ALEXANDER S. BROWN.

The glamour that has surrounded this metal since 1856, when H. St. Claire Deville first obtained it in sufficient quantities to study its physical and chemical characteristics, and the almost monthly presentation before one or other of our scientific societies of papers treating of its properties, etc., make it a most difficult subject to handle with originality. Scientific and newspaper eulogists have expended a great deal of time and many words in extolling the unusual combination of useful properties which it possesses, and have given their imaginations full play in describing its future triumphs in the metallurgical world; but as yet little has been actually accomplished in the way of accurately determining the commercial status and mechanical value of this metal compared to others more familiar to us. While it must be confessed that in certain respects its merits seem such as to warrant great expectations, those interested in its production and its commercial success have experienced not only the usual difficulties inseparable from the introduction of any new metal, but many others due to the too great esteem which the public has been led to bestow upon it. When sufficient knowledge of its characteristics has been acquired to form an unbiased judgment as to its true rank in the metallurgical world, there is little doubt it will be found to be one of the most useful metals ever discovered, and that it will not only largely displace copper, but will make for itself new and important fields of usefulness.

Still, of all the metals commercially familiar to us, aluminium has unquestionably made the most rapid progress. The long and tedious development of iron, steel, copper, tin, lead, zinc, etc., extending over centuries and centuries, is familiar to us all; the fact that this new metal (only discovered in 1827, and extracted in perceptible quantities not earlier than 1854) has already entered into commercial competition with the oldest and most useful metals, substantially at their own prices, would alone make aluminium a most interesting subject of study and speculation.

In the year 1760, or thereabouts, a chemist named Morveau, by calcining alum, obtained a substance which he called alumina. Shortly thereafter Lavoisier suggested the existence of metallic bases in the earths and alkalies, and, naturally, alumina was immediately suspected of being a metallic oxide. Some interesting speculations were indulged in on this subject and this hypothetical metal received the name of aluminium.

As early as 1807 Davy and others tried ineffectually to decompose alumina by various means, including the use of the electric current. A chemist named Oerstedt thought he had produced the metal in 1824, but a German chemist named Wohler was the first to actually demonstrate its existence. He extracted the metal in 1827 by decomposing the chloride of aluminium by means of metallic potassium; 20 years later he also reduced it with metallic sodium. The first commercial product was exhibited in 1854 by H. St. Claire Deville, a French chemist, whose researches as to its chemical and physical properties (fully reported in the French journals of the day) were so thoroughly exhaustive that his writings are still standard authority on the subject. He used several methods, the most successful of which was reduction by sodium. Patronized by Napoleon the Third, who entertained great expectations concerning the use of the metal in war equipment, Deville established commercial works near Paris, which, after varying fortunes, were finally permanently located at Salindres, France, and these works for many years produced substantially all the pure aluminium consumed in the world. It may interest you to know that up to 1886 the annual production of this metal was less than 10,000 pounds, of which 6,000 to 8,000 pounds were produced in France. In 1860 it sold at over $90 per pound. In 1887 it was sold at $5 per pound, and is now selling at $1 for a commercially pure article—this term signifying about 97 per cent. purity in the metal. It is known that by processes now in operation the metal can be produced in large quantities at a price which will put it on a par with copper, bulk for bulk.

Until the dynamo came into commercial use, the production and development of aluminium was almost entirely along chemical lines. It is a metal that possesses remarkable affinity for oxygen and chlorine, and, so far as I know, only potassium and sodium are capable of extracting oxygen and chlorine from it on a commercial scale. Naturally, therefore, the history of its progress is interwoven with that of the commercial manufacture of sodium and potassium. As early as 1856 one M. Alfred Monier, of Camden, N. J., claimed to have successfully made sodium by a continuous process, as a preliminary step in the manufacture of aluminium, and, later, he exhibited several small specimens at the Franklin Institute. This is undoubtedly the earliest record of the production of aluminium in this country.

Three years later, in 1859, the first aluminium works in England were started at Battersea, near London, but no details concerning them are obtainable. In 1860 other works were successfully established at Newcastle-on-Tyne, by Bell Brothers, which were operated with more or less success until 1874. These gentlemen seem to have been close investigators of the subject, and have published important information concerning the characteristics of this metal. Other spasmodic attempts to establish aluminium works were made in Germany and other countries, but it may be truthfully said that France, which created that industry, remained its home until the development of the electrical processes which have now superseded all others. The most important effort on this line was that of Mr. James Webster, who, in 1882, re-established the aluminium industry in England, forming the Aluminium Crown Metal Company at Hollywood, near Birmingham. The principal features of his patent, which this company operated, were the large cheapening of the manufacture of alumina ($Al_2O_3$). He claimed to obtain a product containing about 84 per cent. alumina—a substantial gain upon other known processes—and also to save half the cost of manufacture by utilizing by-products. In fact, this company was for several years a successful competitor in the English markets to the French works at Salindres, though its output was very limited.

About 1886, a young Philadelphian, Mr. H. Y. Castner, invented and secured a number of patents to cover an improved and economical method of making sodium, which, he claimed, reduced its cost to 25 cents per pound. This invention he took abroad, and in 1887 the Aluminium Crown Metal Company was reorganized under the name of the Aluminium Company, Limited, and extensive works for the manufacture of sodium primarily, and of aluminium, secondarily, were erected at Oldbury, near Birmingham. They were completed in July, 1888, and were alleged to have a very large capacity for producing aluminium. The reduction of aluminium at these works was conducted strictly on the lines of Deville's process—Castner's improvements being solely in the cheapening of sodium—and came to be known as the Deville-Castner process. Considerable quantities of metal were produced at these works, and most of it was of exceptional purity. As long as aluminium ruled above $3 a pound they were commercially successful; but inasmuch as it takes nearly three pounds of sodium to make one of aluminium, and the various other steps in the reduction are rather expensive, this process has not been able to compete commercially with the less costly electrical processes, and the Oldbury works are now devoted exclusively to the manufacture of metallic sodium, which finds profitable markets in Germany and elsewhere, being largely used in the chemical manufacture of antipyrene.

During the development of the various sodium processes to which I have above referred the possibility of utilizing electricity was not neglected. Among the earliest patentees in this field were Camille A. Faure, in 1880–84, and R. Grätzel, in 1883. Other inventors before those dates realized the value of electricity in smelting, and other electro-chemical processes, but they were the first to give practical direction to theoretical speculation. Nothing has recently been heard of Faure's process, but that patented by Grätzel in Germany, in 1883, was practically utilized by a firm at Hemelingen, near Bremen, called the Aluminium and Magnesium Fabrik. The Grätzel process consisted, substantially, in electrolyzing a bath of fused chloride or fluoride of aluminium by means of anodes composed of a mixture of carbon and alumina, the current being furnished by a dynamo, but for some reason it was abandoned by the company, in 1887, for another process, the nature of which has been kept a profound secret.

Between 1883 and 1886 a number of inventors secured patents for electrical processes, but I need only mention those which, in the struggle for the survival of the fittest, have come into commercial prominence.

On April 2, 1889, Mr. Charles M. Hall, of Oberlin, Ohio, secured patents for a process of reducing pure aluminium. In this process alumina is dissolved in a fluid bath composed of aluminium fluoride and potassium fluoride, with, perhaps, an addition of lithium fluoride; this bath then being electrolyzed by means of an electric current conveyed to a carbon-lined furnace through an anode of some non-carbonaceous material. In electrolyzing this bath, the containing vessel is made to serve the purpose of the negative electrode. In another patent Mr. Hall claims the use of a bath composed of alumina dissolved in compound fluorides of aluminium with alkaline earthy metals, and in still another patent the use of a bath composed of alumina dissolved in the fluorides of aluminium, calcium and sodium, these materials being obtained by melting together aluminium fluoride, fluorspar and kyrolite. With this latter bath a carbon anode can be used without the bath being affected by its disintegration.

The Hall group of patents is now controlled by the Pittsburgh Reduction Company, of Pittsburgh, Pa., which has had its metal on the market since March, 1889. The plant has a daily capacity for producing about 300 pounds of metal, the selling price of which was $2 per pound until the early part of March last, when it was reduced to $1 per pound for commercially pure aluminium of a guaranteed purity of 97 per cent. The reduction in price, considered in conjunction with the limited amount of pure metal produced, would appear to confirm the generally received impression that while the pure metal is specially adapted to the manufacture of articles of art and ornament, it is not displacing tin, platinum, silver, etc., to anything like the extent its admirers have supposed it would. The fact is, aluminium as a pure metal is not destined largely to supplant other metals in the arts and manufactures; it is to its alloys that we must look to redeem the inflated reputation of the pure metal. The true value and use of aluminium seems to have been forecast by Deville, who predicted for it an intermediate position between the precious and baser metals, in which relation to manufactures he said it was destined to fill a long-felt and important want. He doubtless referred to the pure metal, but, curiously enough, his prediction applies with greater force to its alloys, which have been demonstrated by actual use and thorough tests to possess physical and chemical properties that place them above all other alloys of copper, iron, and in some instances even of steel.

The electric smelting process of the Messrs. Cowles, of Cleveland, Ohio, was the first to secure a commercial footing in this country. These gentlemen have taken out a series of patents covering their process, and they have exhibited very commendable energy and perseverance in establishing a market for their products. Both the process itself and apparatus used have been so frequently and minutely described that they are doubtless familiar to all of you and a recapitulation of its details in this paper would be superfluous. As defined in numerous papers and publications emanating from, or inspired by, the inventors, the process may be described as the reduction of metals by smelting their ores with heat produced by the passage of an electric current through broken resistance material—that is, in the presence of an incandescent material (carbon being generally preferred). Stress is laid on the alleged fact that the reduction is purely and solely a smelting operation, due to a heat far greater than can be obtained by any agency other than the electric current. The electrical (chemical) effect of the current is distinctly disclaimed in their patents and publications. Perhaps I may not unprofitably consume a moiety of your time by explaining that the furnaces used at the company's extensive works at Lockport are rectangular and oblong in shape, comparatively shallow, and are composed exteriorly of walls of firebrick or metal, lined with pulverized charcoal or other form of carbon or similar material of electrical conductivity inferior to the ore to be smelted, this material being generally previously saturated with lime water to increase its resistance to heat. At each end of these furnaces are inserted rods of carbon, which, passing through the walls and linings, are brought very nearly into contact within the body of the furnace, and, being connected to suitable wires or cables coupled to the dynamo, constitute the positive and negative electrodes. The charge consists ordinarily of a mixture (in different proportions) of an electrically resisting material—such as electric light carbon—and the ore to be reduced; though (in cases where the ore itself has sufficient electric resistance) the carbon is sometimes dispensed with. The charge fills the furnace and presses against the sides and ends of the electrodes which project into the furnace. When a current of electricity is passed, the electrodes are so adjusted as to form an arc, and the current then flows from the sides and ends of the electrodes through the broken resistance material, which of course becomes incandescent, and the intense heat developed by this incandescence reduces the ore, the metal flowing to the bottom of the crucible and being subsequently tapped or dipped out when the charge is consumed. The gases liberated in the operation pass out through openings in the firebrick cover of the furnace. From the character of the apparatus and manufacture or operation described, it will be obvious to you that the reduction of the metal is (as claimed by the Cowles company) accomplished by means of heat generated by the passage of an electric current through a mass of high-resistance material, and that, if the chemical effect of the current assists the reduction at all, such utilization is entirely accidental and unsought. Neither aluminium nor any other metal is produced on a commercial scale by this process *as pure metal*.

The principal rival to the Cowles process for producing aluminium alloys is the Heroult process, which reduces aluminium and other metals from their refractory ores in the presence of another alloying metal and is contradistinguished from the Cowles process mainly by the fact that it operates exclusively—or at least almost entirely—by utilizing the chemical or electrolyzing action of the current. This process is the invention of a young French electrical engineer named Paul L. T. Heroult, whose affiliations with the firm of Messrs. Henry Merle & Co., owning and operating the Deville Aluminium Works at Salindres, and his subsequent studies at the Polytechnic schools at Paris and Switzerland first directed his attention to the electrical reduction of aluminium. In 1886–7 he secured French, English and other European patents covering several processes for the extraction of aluminium, silicon, boron, etc., from their ores, both as pure metals and in the form of alloys. On August 14, 1888, he secured a United States patent, No. 387,876, for the process of preparing aluminium bronzes and their alloys, and, it is understood, has pending in the Patent Office a series of applications covering other parts and features of his inventions. Though the Heroult processes have been very little discussed or even described in print, and are therefore almost wholly unknown to the public, their commercial success abroad has been far greater than has attended any other aluminium process; and while those owning the American patents seem as yet to have done little in the way of exploiting them, the success of a small plant put into operation at

* A paper read at the fifty-sixth meeting of the American Institute of Electrical Engineers, New York, April 21, 1891.

Boonton, N. J., for private demonstration purposes, in April, 1890, has been such as to give it rank among the prominent aluminium processes in this country. Having had exceptional facilities for studying the workings of this plant during the past four months, I might be pardoned—especially as so little is publicly known of it—for describing it at length; but as I particularly desire in this paper to direct your attention to the electrical apparatus used at Boonton, by way of illustrating the great power and value of the electrical current in metallurgical operations, it will suffice here to say that the patents of this young engineer, having first been acquired by Swiss capitalists, were afterward bought by the celebrated syndicate which, under the name of the Allegemeinen Electricitäts Gesellschaft, of Berlin, substantially controls the entire electrical field in Germany. This syndicate, after carefully examining all other processes then known, invested 10,000,000 francs in the Heroult process, and are operating very extensive works which obtain their power from the falls of the Rhine, at Schaffhausen. There they produce not only pure aluminium and all its alloys, but also alloys of silicon and other metals. Those works are supplied partly with dynamos of the type I wish especially to describe to you, and partly with dynamos of 600 electrical h. p., a complete description of which I regret I am not able to place before you at this time, as they would interest you. These machines, weighing over 50 tons each, revolve horizontally; they have 24 pole-pieces, with collectors over 12 feet in diameter, and were especially designed for economical work.

To give you a comprehensive idea of the method employed by M. Heroult in manufacturing aluminium and its alloys—and, so far as electrical apparatus is concerned, there is little difference between his and the Cowles process—it will be best to describe the electrical plant and crucible separately.

In the electrical apparatus the most important feature, of course, is the dynamo which generates the current. This machine was designed by Mr. C. E. L. Brown, of the Oerlikon Works, Zurich, specially for electro-metallurgical work, and is the only one of its kind in America. It weighs, complete, over 19 tons, and when driven at 220 revolutions generates a current of 35 volts and 3,500 ampères. The general appearance and design of the machine is very well shown in the following illustration (Fig. 1). It is, as you will observe, a 6-pole machine, having an armature of the Gramme ring type, and the current is taken off commutators at either end by 72 brushes. The armature is 39 inches in diameter, and the shaft (including its clutch) is 11 feet 7 inches long. The commutators are each 19 inches in diameter and 20 inches long, each commutator containing 60 segments weighing 13 pounds apiece, or a total of 780 pounds for the segments for one commutator alone. The core of the armature consists of a very large number of sheet-iron discs clamped together in a frame of aluminium-bronze. About three-eighths of an inch from the outside edge of the core 120 holes pass from one end to the other, through each of which passes a copper wire one-half inch in diameter. These wires, which of course are thoroughly insulated from the core, form part of the winding. The remainder of the winding is composed of copper bars one-quarter of an inch thick, 31 inches long and two and one-quarter inches wide. The shape of these bars and the interior appearance of the armature can readily be seen in this photograph, which was taken about six months ago, while the armature was being repaired in consequence of an accident. Though, as previously mentioned, the works at the Rhine Falls are in part equipped with much larger dynamos, of 600 electrical h. p., it has been found that they do not give nearly as economic results as the other dynamos of the kind I have attempted to describe. This latter type is also in universal use at M. Heroult's own works at Froges, France. At the time a friend visited the Schaffhausen works last summer one of these 150 h. p. machines had been running without a moment's intermission five months and another nearly four months. Though rated at 150 h. p. by the Swiss makers, the same machine in this country would be rated at over 200 h. p., and would be driven at much greater velocity. In actual work they are frequently run up to 300 revolutions, and though it sometimes happens in practical operations that heavy short circuits occur, there is hardly any perceptible sparking at the brushes, even when the current rises to 8,000 or more ampères. The indicator attached to two of these machines (coupled in series) at the Rhine Falls has frequently recorded 25,000 ampères without any evidence of the short-circuiting appearing at the brushes.

At the Rhine Falls, at Froges, and at Boonton, these machines are coupled directly to turbine wheels, arranged pon horizontal shafts. The frame to which the field magnets are attached is a solid casting, weighing alone over nine tons. The field magnets are excited by a smaller dynamo driven by belting from a pulley on the main shaft. This smaller machine was also designed by Mr. C. E. L. Brown, the armature being similar to that of the large machine, except that it has but one commutator. This exciting machine is run at 60 volts and 120 ampères, and its performance is worthy of all praise.

At Boonton the bus wires are eight in number, four positive and four negative; each wire being square and having a cross-section of one inch. They are, in fact, rolled copper bars, uninsulated, because the low potential of the current requires no special insulation. An ammeter is placed in the main circuit, by a simple arrangement, for the guidance of the workman who specially looks after the crucible. The distance from the dynamo to the furnace (which is situated in another room) is only 14 feet. The four positive wires pass directly to the clutch which holds the anode, and the four negative wires pass from the ammeter back to the dynamo.

The crucible (of which this photograph gives a good representation, with the method now in use for raising and lowering the anode) is composed of a strong iron box, which has a deep lining of carbon, previously ground very fine, mixed with sufficient tar and thoroughly compacted on the bottom and around the sides of the containing iron box. After the furnace is thus relined, the carbon is baked in order to drive away the tar and harden the lining. You will see that the position of this crucible is directly the reverse of those used by the Cowles company, and that the carbon crucible itself actually forms part of the electric circuit. Unlike the Cowles process, Heroult's is a continuous process, the reduced metal being tapped from the bottom

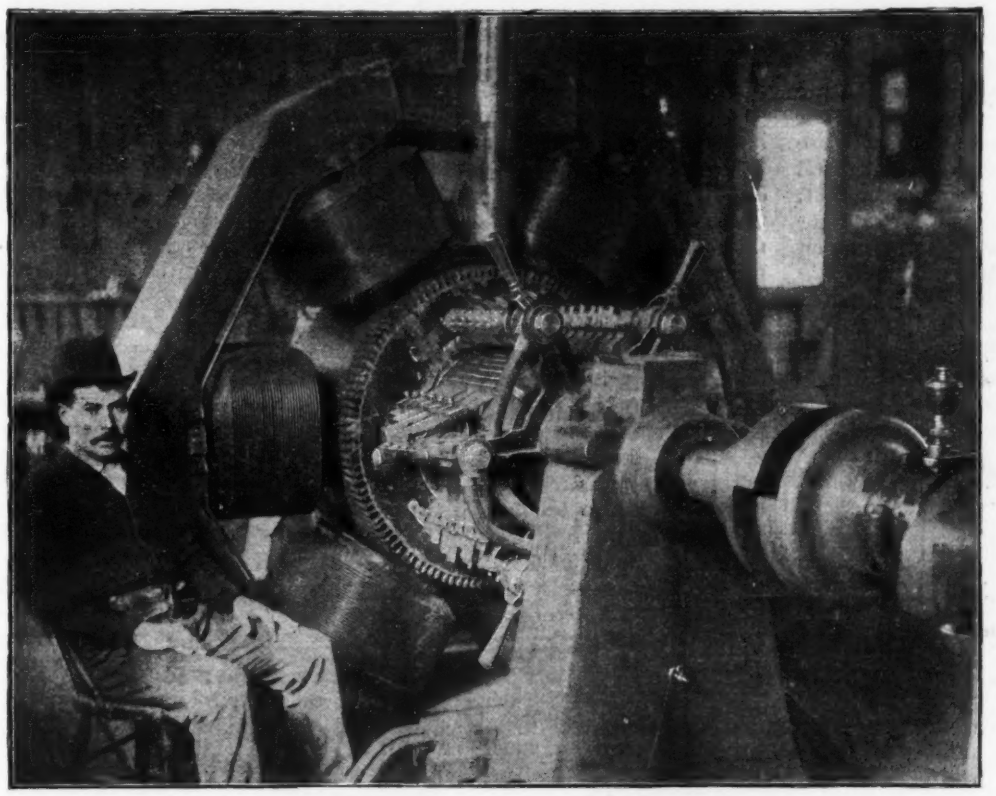


FIG. 1.—OERLIKON DYNAMO AT BOONTON, N. J.

of the crucible, while the machine is merely stopped or slowed down for a few minutes. The interior dimensions of the crucible vary with the ore to be reduced and the size and character of the anode used. Ordinarily it has an interior depth of about 22 inches and a clear space of six inches between the walls and exterior surface of the anode. The electric current passes into the crucible through the suspended carbon anode, the vertical position of which is controlled by an attendant, who lowers it from time to time, to preserve an approximately constant distance between the bottom of the anode and the surface of the molten bath in the crucible. The anode usually dips several inches into this molten bath, and, in practice, the intervening space between its bottom and the surface of the molten metal is kept at about an inch by the attendant, who, by watching the needle of the ammeter, is enabled to maintain the electrode in its proper relative position without difficulty. In order to get as perfect a contact as possible, between the furnace and the cables leading therefrom back to the dynamo, the cables are firmly clamped to a large block of zinc, which projects from the rear of the furnace, and is kept cool by water circulating in pipes, around which the zinc is cast. While, properly speaking, the crucible has no top, as a rule, plates of carbon, imbedded in dry alumina spread over the top of the crucible, are so adjusted as to fit close to the anode in order to retain most of the heat. The mouth of the crucible is formed of slabs of carbon built up funnel shape. The hearth or floor is pierced by a tap hole, which is kept closed by a plug of carbon or fire clay, and is opened from time to time to allow the molten metal to run into a carbon-lined ladle, from which it is cast into ingots.

There are a few distinctive, but not important differences, between Heroult's method of making alloys and reducing pure metals simply. In making alloys, the base alloying metal is first melted in the crucible by the current, or molten metal is poured into the furnace, to form a liquid metallic cathode. This is usually simply and economically accomplished by throwing pieces of the metal—copper for instance—into the furnace, seating the anode upon them, and passing the current. At first the current is very unsteady, and constantly forming between the copper and the anode, but when the copper is entirely melted (and it takes but a very few minutes to melt 200 or 300 pounds) the ore to be reduced is added in sufficient quantities to form a bath, and floats on top of the molten copper. The anode having been raised so as to leave a space of about an inch between its bottom and the molten copper, the current becomes steady, and the operation is established. Thereafter the ore is introduced in small quantities, at frequent and regular intervals, until the desired percentages of aluminium or silicon contained in the alloy have been secured. This percentage can be regulated entirely at will up to about 70 per cent. of reduced metal. No external heat is used, and the process is absolutely continuous at the will of the operatives, which are special features of the Heroult system. The passage of the electric current through the bath serves not only to keep the copper in a fluid state and to melt the ore, but also electrolyzes and decomposes the latter. It is a point of careful regulation in the Heroult processes to maintain only sufficient heat to keep the bath fluid, since any further expenditure is not only useless, but lessens the output. The oxygen from the reduced metal combining with the carbon, of which the anode is composed, is burned with the production of carbonic oxide gas, which escapes from the crucible around the sides of the anode and at the feed hole. The product is withdrawn at intervals by tapping the bottom of the crucible as in ordinary smelting. Each time the metal is tapped, a sample is carefully preserved for accurate analysis, to determine the percentage of contained aluminium.

From a metallurgical point of view, the amount of labor required to operate this process is astonishingly small. The metal produced in the Heroult furnace is sold generally in ingot form, just as it is tapped, without re-melting or being subjected to any purifying manipulation. It is always, however, very pure, sometimes dropping as low as 98½, but generally running over 99 per cent. of absolute purity. This is largely due to the great care exercised in selecting raw materials. In making bronzes, the best Lake Superior copper is used, while the oxide from which the aluminium is reduced is an artificial product, manufactured in Prussia. The number of materials from which aluminium may be reduced by these processes is very large, but the strong influence exerted upon this metal by impurities reduces those ores commercially available in this country to corundum and beauxite, both of which are largely used in making low-grade metal for treating iron and steel. Kryolith, natural or artificial, is another mineral that plays an important part in the commercial production of pure aluminium, since it is the best flux for alumina, the ore from which the metal is generally reduced. There is to a certain extent a diversity of opinion in regard to the value and properties of aluminium, which is partly the natural sequence to the illusions and exaggerated opinion concerning its commercial and practical value, resulting from the romantic descriptions, speculations and suggestions with which our scientific and trade literature has been filled ever since Deville's researches were published, and partly the result of impurities in the metal as ordinarily produced. For thirty-five years after Deville first produced it, aluminium, though much talked of, was but little seen outside of laboratories and lecture rooms, except as we find it on the French and English markets manufactured into ornamental shapes. It is only since 1886 that it has been manufactured in sufficient quantities and at sufficiently low price to permit practical workers to test its properties on an adequate scale. The very unusual qualities which give it merit, and the great depreciation it undergoes when only slightly contaminated with foreign impurities, such as iron and silicon, together with the further fact that it has only been recently commercially produced of ninety-nine per cent. purity, have had a tendency to prejudice this metal in the eyes of practical people. From this depression it will slowly recover as they secure pure metal. In fact this very condition was foreseen by Devilie, who very early pointed out that those handling aluminium and its alloys would be disappointed at the poor results they obtained where they used metal containing more than one per cent. of impurity.

Pure aluminium has a beautiful white color, slightly tinged with blue. It is somewhat fibrous in structure and bends considerably before breaking. If the metal contains more than one per cent. of impurity it becomes brittle and has a crystalline structure. When pure it is soft enough to be easily cut with a knife, while the addition of a few per cent. of impurities makes it exceedingly hard. It melts at a slightly lower temperature than silver, and has

a specific gravity of 2.6. Taking aluminium at 1.0 the following table (from Deville) will be of interest, as showing the comparative weights of the different metals:

| | |
|---|---|
| Platinum | 8.6 |
| Gold | 7.7 |
| Lead | 4 8 |
| Mercury | 4.2 |
| Copper | 3.6 |
| Iron | 2.9 |
| Tin | 2.8 |
| Zinc | 2.8 |
| Aluminium | 1.0 |

The pure metal takes a beautiful polish, uniting with oxygen slowly and with great difficulty, even at a red heat; and when (from long exposure), it finally acquires a very thin coating of oxide, it is not perceptibly tarnished. This coating of oxide protects it from further atmospheric or other baneful influences. It is well known that pure aluminium can be drawn out into the finest wire or into tubes; rolled into plates, stamped into medals (similar to those distributed at the recent Electric Light Convention), beaten into the finest foil, etc. It has an elasticity similar to that of silver, and a tensile strength of about 26,800 pounds per square inch. The addition of six per cent. of copper, however, increases the tensile strength to that of wrought iron, and a slight percentage of silicon raises its strength to 90,000, though at the expense of other qualities.

The compounds of aluminium formed by the addition of copper, brass or iron, are unquestionably the most commercially important of the aluminium alloys. Aluminium combines with copper in all proportions, but its alloys are as easily influenced by impurities as is the pure metal. It is an important fact worth noting that, when alloys are made by mechanically mixing aluminium and copper, iron, etc., the product must be re-melted a number of times to secure any uniformity in the texture of the alloy. The finest alloys, by far, are those made by uniting the aluminium to the basic metal in atomic proportions, as it is reduced, as in the Heroult process, the uniformity of whose alloys is remarkable. Probably the most useful compound of aluminium and copper is what is known as 10 per cent. bronze, containing 10 per cent. aluminium and 90 per cent. of copper. This alloy is an almost perfect imitation of gold in color, and is susceptible of taking and retaining a most beautiful polish. It can be rolled, or drawn, or cast very readily, but in casting the bronze shrinks considerably, and care must be taken to have the feeders amply large. The tensile strength of this bronze is enormous, and the following table from "Trautwine Engineer's Pocket Book" shows it in comparison with other metals

| | Tensile Strength. |
|---|---|
| Cast brass | 23,000 |
| Annealed brass wire | 49,000 |
| Cast copper | 24,000 |
| Copper bolts | 33,000 |
| Annealed copper wire | 32,000 |
| Gun bronze of copper and tin (cast) | 39,000 |
| Cast iron gun metal, U. S. ordnance | 30,000 |
| Average American cast iron | 16,000 |
| Good wrought iron | 50,000 |
| Best American wrought iron, exceptional | 76,000 |
| Iron wires, rope | 38,000 |
| Malleable iron castings | 48,000 |
| Steel plates (rolled) | 81,000 |
| Cast steel, average Bessemer ingots | 63,000 |
| Aluminium bronze, in castings, over | 100,000 |
| Aluminium bronze "special" in castings up to | 130,000 |

## The Cultivation of India Rubber.

In a recent letter to *Nature* Mr. W. R. Fisher gives some interesting particulars with regard to rubber cultivation in Assam. After some preliminary experiments, the government of Assam in 1873 determined to plant caoutchouc in the Charduar Forest at the foot of the Himalayas. This district is essentially damp, and the moist, hot atmosphere in the summer months resembles that of a forcing house. The plan of concentrating rubber trees in artificial plantations was carried out as follows: At first attempts were made to propagate by cuttings, but it was soon discovered that rubber seed germinated freely on well-drained beds covered with powdered charcoal or brickdust, and that the seedlings, though at first small, became about two feet high in 12 months, and were much hardier against drought than plants produced from cuttings.

In order to imitate nature as much as possible, some strong seedling rubber-plants were placed in the forks of trees in 1874, but by 1885 only a few of them had reached the ground and were growing. Large nurseries were ultimately formed, in which the plants were retained until they were 10 feet high and then planted out in belts of 40 feet, separated by alternating strips of untouched forest 60 feet wide. It was found that the rubber-plants did not get sufficient light with lines less than 40 feet broad, whilst the strips of forest kept the soil and atmosphere moist, and afforded side shelter to the plants, forcing them to grow upward. As this method involved considerable expense in clearing the lines, and wasted the wood, which was frequently unsalable, the Chief Commissioner of Assam, in 1874, directed that plantations of *Ficus elastica* should also be made in grass-land near Tezpur. The trees, however, when tapped, yielded scarcely any rubber. An area of only 8 acres was therefore planted out near Tezpur, whilst the area of the Charduar plantation in 1889 was 1,106 acres, and contained 16,054 plants, besides large nurseries with 84,000 seedlings. The present average annual growth in height and girth, taken from 350 plants, are respectively 5 feet 2 inches and 8 inches. The care of the plantation consists chiefly in clearing the lines round the plants, but four years after planting the undergrowth is well kept down by the shade of the rubber trees. Experimental tappings were made in 1883 and 1884 on 50 natural growth rubber trees in the Charduar Forest, the total yield being 438 pounds in 1883 and 206 pounds in 1884, giving an average yearly yield of 6½ pounds per tree.

## Some Possible Modifications in the Methods of Protecting Buildings from Lightning.*

BY N. D. C. HODGES.

Ordinarily a lightning rod is regarded as a conduit or pipe for conveying electricity from a cloud to the ground. The idea is that a certain quantity of electricity has to get to the ground somehow; that if an easy channel is opened for it the electricity will pass quietly and safely; but that if obstruction is introduced, violence and damage will result. This being the notion of what is required, a stout copper rod, a wide-branching and deep-reaching system of roots to disperse the charge as fast as the rod brings it down and a supplement of sharp points at a good elevation to tempt the discharge into this attractive thoroughfare are naturally guaranties of complete security.

About two years ago one of the oil tanks at Communipaw or Bayonne, just off the Jersey City Central Railroad, was struck by lightning; and, as I pass that way each day, my attention was again called to the question how we should protect our buildings from lightning; and one evening, taking up Silvanus P. Thompson's little book on electricity, I think it was, to see what he had to say about lightning, I re-read the ordinary theory of the formation of the high potentials that are manifested in lightning discharges.

This theory is simply this: that if in the cloud there is a certain quantity of electricity distributed on a given mass of fine mist, it will exist there at a certain potential, depending on the capacity of this finely divided matter. Now, if these mist particles coalesce into raindrops, the theory points out that there would be a decrease in the electrical capacity, and a consequent increase in the potential of the charge. It occurred to me immediately that if this theory had any foundation in fact it ought to be possible to reverse the operation on the surface of the earth; that is, to receive the lightning discharge on some large body, which would then be broken up into fine particles of vapor, which would have a considerably greater electrical capacity, and that the potential of the discharge would thereby be materially reduced, and the effects of the lightning mitigated. This was my hypothesis to work upon, and I immediately began to look through the records to see what actually happened in the case of lightning discharges, and to see if there was any support in fact for my hypothesis.

The first book at hand was Sir William Thomson's "Papers on Electricity and Magnetism," and I found that he described in detail the case of a farmhouse in Scotland, which was struck by lightning, and in which this very dissipating effect took place; this is, the bell wires were dissipated, an occurrence which, as you know, is extremely common when a lightning discharge takes place. I went on through the records, and found numberless cases of this, the oldest being that of the dissipation of the metal covering on the wooden shield of some Greek warrior. I mention this case as of interest, as it brings out a very fortunate circumstance, that when thin metal is dissipated against wood or even against plaster, no harm results to the wood or plaster. Of course you know that it has been somewhat discussed whether this action is a dissipation through the heating of the metal, or whether it is a cold dissipation —a breaking-up into particles, as it were—of the metal. On this point I have nothing to say.

Let me describe here in Franklin's own words a typical case of the action of a small conductor dissipated by the discharge.

Franklin, in a letter to Collinson read before the Royal Society, Dec. 18, 1755, describing the partial destruction by lightning of a church tower at Newbury, Mass., wrote: "Near the bell was fixed an iron hammer to strike the hours; and from the tail of the hammer a wire went down through a small gimlet-hole in the floor that the bell stood upon, and through a second floor in like manner; then horizontally under and near the plastered ceiling of that second floor till it came near a plastered wall; then down by the side of that wall to a clock, which stood about twenty feet below the bell. The wire was not bigger than a common knitting needle. The spire was split all to pieces by the lightning, and the parts flung in all directions over the square in which the church stood, so that nothing remained above the bell. The lightning passed between the hammer and the clock in the above-mentioned wire, without hurting either of the floors, or having an effect upon them (except making the gimlet-holes, through which the wire passed, a little bigger), and without hurting the plastered wall or any part of the building, so far as the aforesaid wire and the pendulum wire of the clock extended, which latter wire was about the thickness of a goose-quill. From the end of the pendulum, down quite to the ground, the building was exceedingly rent and damaged. . . . No part of the aforementioned long, small wire between the clock and the hammer could be found, except about two inches that hung to the tail of the hammer and about as much that was fastened to the clock; the rest being exploded, and its particles dissipated in smoke and air, as gunpowder is by common fire, and had only left a black, smutty track on the plastering, three or four inches broad, darkest in the middle, and fainter toward the edges, all along the ceiling under which it passed and down the wall."

I would thus formulate what seems to be true, that a conductor which can be easily dissipated by a lightning discharge protects the building to which it is attached between two horizontal planes, the one passing through the upper end of the dissipated conductor and the other through the lower end; and it is this one point that I would urge upon the consideration of the Institute.

I have taken the time of the Institute to tell how I reached this conclusion; but, as must always be, I reached it by making some false digressions. So far as I know, therefore, a conductor such as I have here—a conductor made of light copper ribbon, so that 75 feet of it will weigh only a pound, and made in sections two feet long, which shall be tacked to the building from its ridge-pole to the foundation, the joints being made of low conductivity by the insertion of insulating washers—will protect the building. The conductor will be destroyed by the discharge. Its destruction can take place even against a plastered wall without injury to the wall; but no other harm will occur so far as the conductor extends in a vertical direction.

In order to destroy a building in whole or in part it is necessary that work should be done; that is, energy is required. Just before the lightning discharge takes place the energy capable of doing the damage which we seek to prevent exists mainly in the column of air extending from the cloud to the earth, in some form that makes it capable of appearing as what we call electricity. We will therefore call it electrical energy. What this electrical energy is it is not necessary for us to consider; but that it exists there can be no doubt, as it manifests itself in the destruction of buildings.

The problem that we have to deal with, therefore, is the conversion of this energy into some other form, and the accomplishment of this in such a way as shall result in the least injury to property and life.

Lightning rods were introduced with the idea that the electricity existing in the lightning discharge could be conveyed around the building which it was proposed to protect, and that the building would thus be saved.

The question as to the dissipation of the energy involved was entirely ignored, naturally, and from that time to this, in spite of the best endeavors of those interested, lightning rods constructed in accordance with Franklin's principle have not furnished satisfactory protection. The reason for this is apparent when it is considered that this electrical energy existing in the atmosphere before the discharge, or, more exactly, in the column of dielectric from the cloud to the earth, reaches its maximum value on the surface of the conductors that chance to be within the column of dielectric; so that the greatest display of energy will be on the surface of the very lightning rods that were meant to protect, and damage results, as so often proves to be the case.

Having cleared our minds, therefore, of any idea of conducting electricity, and keeping clearly in view the fact that in providing protection against lightning we must furnish some means by which the electrical energy may be harmlessly dissipated, it seems clear why it is that the use of sufficient energy to dissipate a pound of copper leaves not enough to do harm to other objects around.

I am now coming to a point that I want to make clear, and that is that, according to the usually accepted theories of electrical action, this electrical energy is gradually stored up in the column of dielectric from the cloud to the earth, and that it is distributed in this column with the greatest amount per cubic foot along some central core, this amount not exceeding one foot-pound per cubic foot, and that this process can be continued until the stress is so great that the air breaks down, when what we call a discharge of lightning takes place, and the electrical energy disappears, of course, only to take on some other form. You may say that the electricity travels from the cloud to the earth, or from the earth to the cloud, whichever you please; at any rate, there is an electrical action in a vertical direction, the discharge being supposed vertical. I will ask, however, whether it is not true that the energy involved travels along the equipotential lines; that is, travels in the main horizontally. It seems to me that it shrinks in, as it were, from the considerable column or ellipsoid of dielectric upon the central core, where it manifests itself as heat and light in the electrical flash. It will, then, be clear how it is that in providing a body upon which the dissipation of energy shall take place we have to guard against something not coming from above or below, but moving from the side, and that this may be the explanation of why it is that, so far as I have been able to find, a dissipatable conductor protects the building between two essentially plane surfaces passing through its upper and lower ends.

But let all this be as it may, the main point which I would urge upon your consideration is that by giving the electrical energy something which experience shows it will readily dissipate, that is, a conductor of varying resistance and small size, we can but mitigate the effects of lightning discharges, so long as the conservation of energy holds true. I will only repeat that I have so far found no case

*Abstract of a paper read at the fifty-sixth meeting of the American Institute of Electrical Engineers, New York, April 21, 1891.

on record where the dissipation of such a conductor has failed to protect the building under the conditions already explained.

## Measurement of the Power Given by Any Electric Current to Any Circuit.

BY PROF. W. E. AYRTON, F. R. S., AND W. E. SUMPNER, D. SC.

### I.

During the meeting of the Electrical Congress at Paris in 1881 one of us* devised a method of using an electrometer for measuring the power given to any circuit by any current. The accuracy of the method is wholly independent of the nature of the circuit, which may possess self-induction, mutual induction, capacity and an E. M. F., as well as of the nature of the current, which may be constant, intermittent or alternating, according to any function of the time. This method is the only electrical one published up to the present date, the accuracy of which is not based on assumptions, either as regards the nature of the current or as regards the entire absence of self and mutual induction from a circuit some portion of which is necessarily of a solenoidal form, or as regards the nature of the circuit the power given to which we desire to measure.

In view, then, of the present wide use of alternating currents for industrial purposes, it might have been expected that this electrometer method of measuring the power given by any intermittent or alternating current to an inductive circuit would have been extensively employed. Unfortunately, however, as pointed out by one of us in conjunction with Professor Perry,† the use of this method is restricted by the fact that Sir W. Thomson's quadrant electrometers do not generally obey the mathematical law given for these instruments in textbooks,‡ as it was supposed they did when this electrometer method of measuring power was first suggested. And hence the main result that has up to the present time followed from the publication of this method has been the stimulation of inventive minds to devise forms of electrometers in which the textbook law is strictly fulfilled.

In 1888 Mr. Blakesley published a very ingenious method for using three dynamometers to measure the power given by an alternating current to the primary coil of a transformer. His original proof, a geometrical one, was based on various hypotheses, among others that the primary and secondary currents and the magnetic flux were sine functions of the time.

Recently one of us, in conjunction with Mr. Taylor, has published § an analytical proof showing that Mr. Blakesley's three-dynamometer method of measuring power gives equally true results, whatever functions the currents and magnetic flux be of the time. There still, however, remains a serious objection to this method, viz., that it assumes the absence of magnetic leakage in the transformer, or in other words that the number of lines of force embraced by one convolution of the primary coil at any moment is the same as the number of lines of force embraced by one convolution of the secondary. Further, the three-dynamometer method cannot be used to measure the power given to a single circuit, as the coils of one of the dynamometers have necessarily to be put in different circuits.

The employment of an electromagnetic wattmeter for the measurement of electric power is well known, and investigators have considered the error that is introduced into wattmeter measurements made with alternating currents on account of the fine-wire circuit of the wattmeter possessing self-induction. This fine-wire circuit usually consists of a suspended coil in series with a so-called non-inductive stationary high resistance, and various devices have been adopted by different experimenters to make the effective self-induction of this fine-wire circuit nought. One of the simplest of these devices, we venture to think, is that proposed by one of us in conjunction with Mr. Mather, and which consists in winding the stationary so-called non-inductive resistance in such a way that the capacity of this doubly wound coil practically neutralizes the effect of the self-induction of the suspended coil.

Several months ago, however, while working at alternate current interference, we noticed that it was possible to employ an extremely simple method, based on the difference of phase of the P. D. and the current for measuring the power by *any* current to *any* circuit. This method, which has since been in regular use in the laboratories of the Central Institution, is quite independent of any assumptions as to the nature of the current, or of the circuit, the power given to which it is desired to measure; and it has the further great advantage that the only measuring instrument required is the ordinary alternate-current voltmeter of commerce.

In series with the circuit *ab* (Fig. 1), the power given to which we desire to measure, connect a non-inductive resistance *bc* of *r* ohms.

Let $V_1$, $V_2$ and $V$ be the readings of the voltmeter when applied between *a* and *b*, *b* and *c* and *a* and *c*, respectively; then, if *W* be the mean watts supplied to the circuit *ab*, we have in all cases, whatever the nature of the current or of the circuit *ab*:

$$W = \frac{1}{2r}(V^2 - V_1^2 - V_2^2) \qquad (1)$$

For, let $v_1$, $v_2$ and $v$ be the instantaneous values of the P. D. between *a* and *b*, *b* and *c* and *a* and *c* at some moment *t*, then

$$v = v_1 + v_2. \qquad (2)$$

If *a* be the current in ampères flowing through the circuit at time *t*, then $av_1$ equals the watts *w* given to *ab* at that time. But

$$a = \frac{v_2}{r},$$

since the resistance *bc* is non-inductive;

$$\therefore w = \frac{v_1 v_2}{r}.$$

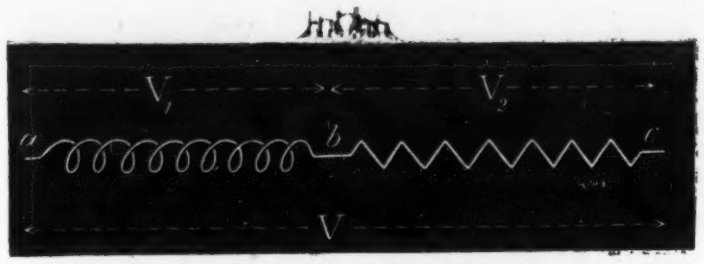



FIG. 1.—AYRTON AND SUMPNER'S EXPERIMENTAL APPARATUS.

Then, squaring (2), we have:

$$v^2 = v_1 + 2v_1 v_2 + v_2^2;$$

$$\therefore w = \frac{1}{2r}(v^2 - v_1^2 - v_2^2).$$

Consequently,

$$\int_0^T w\,dt = \frac{1}{2r}\left(\int_0^T v^2 dt - \int_0^T v_1^2 dt - \int_0^T v_2^2 dt\right),$$

or

$$W = \frac{1}{2r}(V^2 - V_1^2 - V_2^2),$$

the equation given above.

If the resistance of *b c* be not known, or if there be any fear that it may be changed by the passage of the current, then an ammeter (an alternate-current ammeter, of course, if alternate currents be employed) can be inserted in the circuit. Let *A* be the reading of this ammeter, and which represents the square foot of the mean square of the current, then, for *r* in (1) we may substitute $V_2/A$, or

$$W = \frac{A}{2V_2}(V^2 - V_1^2 - V_2^2). \qquad (3)$$

When employing this last formula, the non-inductive resistance, *bc*, may be that offered by incandescent lamps,

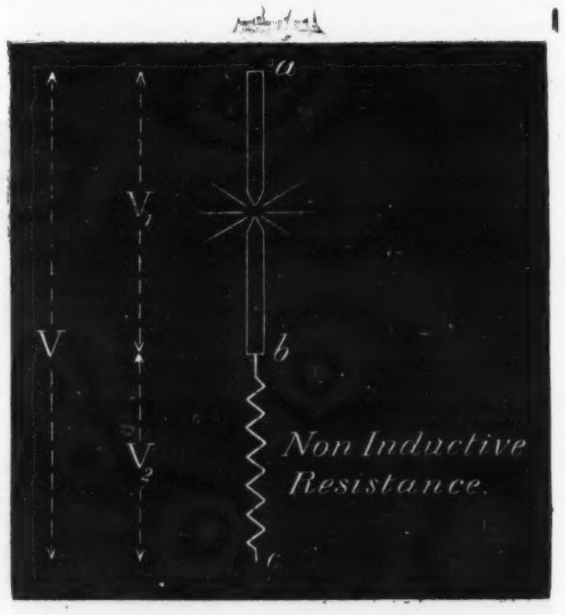



FIG. 2.—AYRTON AND SUMPNER'S EXPERIMENTAL APPARATUS.

since there is no objection to the resistance varying with different mean strengths of the current employed.

This voltmeter method of measuring power was arrived at quite independently of the electrometer method referred to above, but an examination of the electrometer method shows that it is practically equivalent to simultaneous measurements of three P. D's.

### III.

The method which we have described for measuring the power by *any* current to *any* circuit may be conveniently employed for measuring the power given to an alternating-current arc, or to an alternating-current arc lamp. It is known that an alternating-current arc requires a greater current than a direct-current arc to produce the same light with similar carbons; for example, a 10-ampère direct-current lamp requires 12½ ampères, or 25 per cent. larger current, when used with an alternating current. In a masterly paper on "The Theory of Alternating Currents," read before the Society of Telegraph Engineers on Nov. 13, 1884, Dr. Hopkinson refers to a law given by Joubert, that the difference of potential between the carbons in an alternating arc is of approximately constant numerical value throughout the period, and that it reverses sign discontinuously at each reversal of the current. Using this law as his basis, he works out mathematically some very curious relationships between the variations of current and P. D. with time.

Three of our senior students, Messrs. Kolkhorst, Thornton and Weekes, have been making a number of experiments on the power supplied to alternating-current arcs by using the method of measuring power described above. From these experiments it would appear that the quality of the carbon employed affects materially the difference in phase between the currents passing through the arc and the P. D. between the carbons. If the arc be quite steady and only give out the rhythmic hum that accompanies a good arc, such as can be obtained with cored carbons of proper quality, the arc appears to act practically as a simple resistance, and M. Joubert's law does not hold. But if the arc be maintained between uncored carbons of poor quality, and be hissing, there is considerable difference in phase between the current and the P. D. between the terminals; further, the experiments show that current is very far from being a sine function of the time, although produced by a dynamo whose E. M. F. normally follows a harmonic law.

We do not purpose, in this communication, to enter at length into these experiments on alternate-current arcs, but a few examples of the experimental results that have been obtained will be interesting as illustrating the ready applicability of this new method of measuring power to such investigations.

In addition to the difference of phase of P. D. and current that may be produced in the arc itself, there is the electromagnet to be considered by which the distance between the carbons is usually regulated in arc lamps. This electromagnet will introduce lag between the P. D. at the terminals of the lamp and the current passing through the electromagnet and the arc in series; and hence, even although the arc be perfectly steady, we find, even in the case of a Brush lamp especially intended for alternate currents, that the true power supplied to the electromagnet and arc is 20 per cent. less than the product of the readings of the ammeter and the voltmeter attached to the lamp terminals, and which gives the square root of the mean product of the squares of the current and P. D.

If, however, the arc be between common carbons and be hissing, the difference, we find, is much greater. With cored carbons this Brush lamp requires a P. D. of about 35 volts to be maintained between its terminals; but if these cored carbons be replaced by common carbons and the arc be hissing, the P. D. between the terminals of the lamp at once rises to 45 or even 50 volts, although the current passing through the lamp and the amount of light given out remain practically as before. And then we find that the true power supplied to the lamp may be only one-half of the square root of the mean product of the squares of the current and P. D., so that the readings of the ammeter and voltmeter alone make the apparent power twice as great as the true power.

For the purpose of easily estimating the ratio of the true to the apparent power supplied, formula (3) may be thus written:

$$W = AV_1\left\{1 - \frac{(V_1 + V_2 - V)(V_1 + V_2 + V)}{2V_1 V_2}\right\}. \qquad (4)$$

from which we see that the expression in the brackets represents the ratio of the true to the apparent power supplied to the lamp or other circuit *ab* (Fig. 1). Hence the percentage error made in assuming that the power supplied to any circuit was the product of the ammeter and voltmeter readings would be in all cases, whatever the nature of the current or of the circuit,

$$100\,\frac{(V_1 + V_2 - V)(V_1 + V_2 + V)}{2V_1 V_2}. \qquad (5)$$

The following are samples of the results obtained with a hand-regulated lamp, there being no electromagnet at all in series with the arc (Fig. 2). The carbons were not cored and the arc was hissing. The frequency was maintained at 200 periods per second:

TABLE I.

| Square Root of Mean Square | | | | |
|---|---|---|---|---|
| Of P. D. in volts between | | | Of current in ampères. | Percentage error in estimating power formula (5). |
| *a* and *b*. $V_1$. | *b* and *c*. $V_2$. | *a* and *c*. $V$. | *A*. | |
| 55.0 | 60.0 | 108.0 | 12.3 | 24.0 |
| 45.4 | 75.4 | 107.3 | 11.8 | 45.8 |

For the purpose of obtaining an idea of $\varphi$, the angle of phase difference produced by the hissing arc, between the current and the P. D., we may assume that the P. D. and current are sine functions of the time; then, as may be easily proved,

$$\cos\varphi = \frac{V^2 - V_1^2 - V_2^2}{2V_1 V_2}; \qquad (6)$$

and the values of $\varphi$ for the two tests given above come out as 40° 20′ and 57° 10′. It will of course be observed that this assumption of a harmonic law for the P. D. and current for the purpose of obtaining some idea of the value of $\varphi$ in no way affects the generality of the method for the

* This method was simultaneously arrived at independently by Professor Fitzgerald.

† *Journal of the Society of Telegraph Engineers and Electricians*, v 1. 17, 1888.

‡ We may mention that an investigation on Quadrant Electrometers has been going on from time to time at the Central Institution for the last five years, and we had hoped to have communicated the complete report long before this to the Royal Society.

§ Meeting of Physical Society, Feb. 27, 1891.

measurement of the power, since this is based on no such assumption.

The following are samples of the results obtained with a Brush alternate-current lamp regulated by an electromagnet (Fig. 3), the carbons not being cored, and the arc hissing. The frequency was mantained at 200 periods per second.

TABLE II.

| Square Root of the Mean Square | | | | | |
|---|---|---|---|---|---|
| Of P. D. in volts between | | | Of current in ampères. | Percentage error in estimating power formula (5). | Lag between current and P. D. |
| $a$ and $b$ $V_1$. | $b$ and $c$ $V_2$. | $a$ and $c$ $V$. | | | $\varphi$ |
| 64.8 | 58.0 | 108.4 | 13.0 | 44.0 | 56° 0′ |
| 59.8 | 64.2 | 107.4 | 12.0 | 50.5 | 60 20 |
| 55.0 | 67.3 | 107.4 | 10.6 | 47.0 | 58 30 |

The experiments already described tell us that a hissing arc may cause a considerable phase difference between the P. D. and the current, but they do not enable us to decide whether such an arc causes the current to lag behind the P. D., or to lead in front of it. To decide this point, that is, to decide whether a hissing arc acts like an inductive coil, or a condenser, a variety of experiments were made by putting induction or capacity in series with the arc. The following gives the result of one such experiment: In series with a hand-regulated lamp (and, therefore, containing no electromagnet), was placed a condenser of 89 microfarads (Fig. 4). Uncored carbons were used, and they were adjusted so that the arc was very short at first: the carbons were then not touched, and, as they burnt away, the arc grew longer and longer until it finally went out. The frequency was maintained at 200 periods per second.

TABLE III.

| Square Root of Mean Square | | | | | | |
|---|---|---|---|---|---|---|
| E. M. F. of dynamo in volts. | Of P. D. in volts between | | | Of current in ampères. | Sum of $V_1 + V_2$. | Lag between current and P. D. |
| | $a$ and $b$ $V_1$. | $b$ and $c$ $V_2$. | $a$ and $c$ $V$. | $A$. | | $\varphi$ |
| 50 | 35.4 | 89.0 | 72.3 | 12.0 | 124.4 | 129° |
| | 38.0 | 92.0 | 73.3 | 12.5 | 130.0 | 133 |
| | 51.2 | 104.5 | 74.3 | 14.0 | 155 7 | 135 |
| | 69.2 | 86.5 | 67.5 | 13.4 | 155.7 | 131 |

Comparing $V$ with the E. M. F. of the dynamo we see that the arc and the condenser together acted as a condenser on the whole; but, comparing $V$ with $V_1 + V_2$, we see that the arc acted as an induction and not as a capacity.

It having been conclusively proved that a hissing arc with uncored carbons acts as an induction, it was interesting to compare the impedance it produces with the impedance produced by the ordinary regulating electromagnet of the lamp. The arc itself seen in Fig. 3 was, therefore, short-circuited, and the following measurements made, $V_2$ now being the square root of the mean square of the P. D. between the terminals of the regulating electromagnet, $V_2$, as before that between the terminals of the non-inductive resistance, and $V$ that between $a$ and $c$, the arc, as already explained, being short-circuited. The frequency was maintained at 200 periods per second.

TABLE IV.

| $V_1$. | $V_2$. | $V$. | $A$. |
|---|---|---|---|
| 35.4 | 69.2 | 82.0 | 11.3 |
| 35.4 | 65.6 | 80.0 | 11.4 |

We have, then, P. D. measurements giving the phase difference of current and P. D. with the arc alone (Table I. and Fig. 2); with the arc and regulating electromagnet (Table II. and Fig. 3); and with the electromagnet alone (Table IV.). Defining impedance in the usual way as the ratio of the square root of mean square of P. D. to the square root of mean square of current, we find from the two sets of results given in Table I. that

the impedance of the arc alone equals..... { 4.47 / 3.78;

from the three sets of results given in Table II., that

the impedance of the arc and electromagnet equals { 4.87 / 5.15; / 5.14

and from the two sets of results given in Table IV., that

the impedance of the electromagnet alone equals... { 3.14 / 3.16

In order to test whether the current follows a harmonic law, let us assume that it does, then find what result this assumption leads to, and, lastly, see whether the experiments confirm this result or not. Let, therefore, the instantaneous current at any moment be of the form

$$\frac{V_0}{\sqrt{(r^2 + L^2 p^2)}} \sin(pt - q),$$

where $r$ is the effective resistance in each case, viz., the ratio of the *true* watts given to the circuit divided by the mean square of the current in ampères, and where $p$ equals $2\pi n$, $n$ being the number of periods per second. In each of the seven experiments referred to in Tables I., II. and IV. $n$ was 200.

The seven values of $r$ in ohms corresponding with the seven values of the impedance given above are for the

Arc alone..... { 3.42 / 2.07.

Arc and electromagnet..... { 2.65 / 2.66. / 2.71

Electromagnet alone..... { 0.44 / 0.54.

And, since the impedance equals $\sqrt{(r^2 + L^2 p^2)}$, if the harmonic law be true, the corresponding values of $Lp$ are, for

Arc alone..... { 2.88 / 3.16.

Arc and electromagnet..... { 4.08 / 4.41. / 4.37

Electromagnet alone..... { 3.12 / 3.11.

But if the harmonic law hold for the current, the sum of $Lp$ for the arc alone, plus the $Lp$ for the electromagnet

FIG. 3.—AYRTON AND SUMPNER'S EXPERIMENTAL APPARATUS.

alone, must equal the $Lp$ for the arc and electromagnet, since $p$ has the same value in each case. Now, it is obvious that the condition is far from being fulfilled with the numbers just given. Hence the current does not follow a harmonic law.

It is interesting to notice that the $Lp$ for the hissing arc alone is actually greater than the $Lp$ for the regulating electromagnet.

The values given above for $r$, being obtained by dividing the *true* watts by the mean square of the current in ampères, are the effective resistances in ohms—whether the current follows a harmonic law or not. Hence, by comparing the value of $r$ for the regulating electromagnet alone with its resistance in ohms, measured with a steady current, we have a true measure of the waste of energy in the iron core of the electromagnet due to hysteresis and

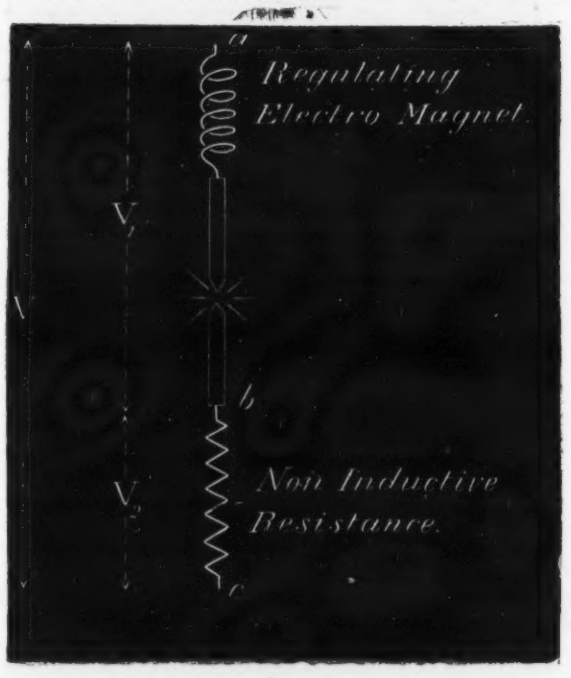



FIG. 4.—AYRTON AND SUMPNER'S EXPERIMENTAL APPARATUS.

Foucault currents. Now the resistance of this electromagnet for a steady current is only 0.065 ohm; hence 90 per cent. of the energy given to the regulating electromagnet of this Brush lamp is wasted in heating its iron core when the frequency is 200. Here again we have a further illustration of the importance of being able to measure, by means of the simple method we have described, the power given by any current to any circuit.

*(To be continued.)*

## The London-Paris Telephone and the Press.

London and Paris have now been put into telephonic communication, but the question is whether the proposed tariff will not prove too high. On this question, says the *Pall Mall Gazette*, a Belgian journalist writes: "The *Indépendance Belge* employs the Paris-Brussels telephone for 60 minutes every day regularly, and on important occasions for double that duration. Most leading Continental journals do the same, so that if the rate of the London-Paris telephone were available by its moderation, it would be a paying concern for the postal authorities at once, whereas at the present price it will remain almost completely unused. Another interesting fact is that whereas Belgium is connected with the London-Paris telephone through the Brussels-Paris line, it is further connected with Germany by a telephonic line running to the frontier at Herbesthal. Germany, as well as France and Belgium, would be a customer of the cable, therefore, were it not for those forbidding prices, which become increased still further in the Belgian or German cases, seeing that if, for instance, a German paper were to take 20 minutes' communication in London for Paris, it would have to take and pay for another 20 minutes to transmit the news from Paris to Brussels, and then a further 20 minutes to transmit it from Brussels to Herbesthal. I believe also that the French authorities are quite ready to make the price as cheap as possible, if not for the general public, at least for the press, which is the best, because the most regular and permanent, customer of the telephone. The obstacle, therefore, is one specially created by the English authorities. In illustration of this I may say that in the case of the Brussels-Paris telephone the authorities first satisfy the requirements of the press, and only reserve to the communications of private persons such time as is left free by newspaper conversations." As was announced in our cable dispatch last week, the average number of messages per day sent over the line has so far been about 50.

## Edison's Boyish Ambition.

In last Saturday's *Continent* Mr. Edison gives the following interesting account of his earliest aspirations as to what he wanted to do when he became a man:

As a little boy I wanted to do the various things that attracted my attention, and had always some scheme afoot that completely absorbed my interest.

I couldn't begin to recall all those fanciful aspirations of that busy boyhood. But I think about the first thing I attempted was to be a gardener, owing to the fact that my father had a ten-acre garden lot. With another boy I got my father's permission to plant six acres of turnips on shares. Well, we started in, and putting the seeds not less than fourteen feet apart, had the whole lot "done" in two hours and a half. The trouncing my father gave me for that practically ended my brief career as a gardener.

That was when I was nine years old. It was about this time that all my spare hours were given to organizing a secret service among my companions and digging caves in which to meet, suggested by my reading Sylvanus Cobb, Jr.'s, stories—particularly "The Gunmaker of Moscow." We dug a cave with a concealed trap door, and then from this an inner dungeon, fitted up with a fireplace, table, chairs, papers, games and a stock of provender laid in from the old gentleman's garden.

At one time, in an effort to accumulate wealth by collecting old scrap iron, I went so far as to tear the zinc from under my mother's stove. But a new field was opened to me when I was about 12 years old by the coming of a railroad to our place. At first I was dead set on being engineer of a locomotive. By persevering bribes of apples and cigars I won favor with one of the firemen, and was permitted the freedom of the cab at waiting times. This was a pleasure I never tired of.

In the years that followed of my experience as a trainboy merchant, with a rushing business, rapidly on the increase, I never lost my interest in the engine. Many a time I employed a substitute so that I might take the trip in the engine. Often I was permitted to handle the machinery, to shovel coal and rub up the brass and steel work. I couldn't have been over thirteen years old when I did run a freight train all alone for sixty-two and a half miles with the fireman dozing in the cab.

I knew a thing to be looked out for was to have enough water to avoid an explosion. The result was that I got too much water, and before long it rose in the smokestack and poured out a dirty stream of muck all over the shining boiler and rods and wheels.

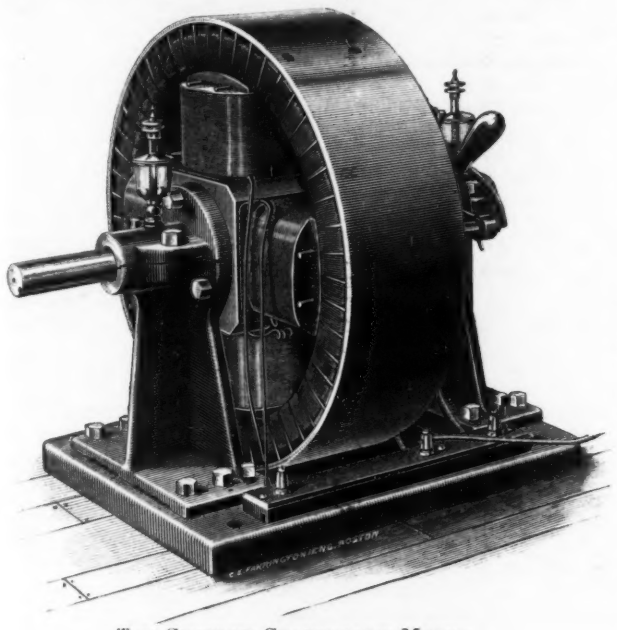
It was as a news agent that my attention was first called to the practical importance of the telegraph. By sending ahead along the road first edition headlines of the news of the battle of Shiloh I was enabled to dispose of a thousand papers at an enormous profit. From that time I was resolved to be a telegraph operator, and in five months I secured a good position. While at this I practiced taking press reports at night on plugged wires until in an emergency I got the longed-for post at the end of a through wire at a good salary.

While I was trainboy I began to read the papers I sold, and was ambitious to run a newspaper. I still have some copies of a little paper I printed on a stamp press during my waits on the baggage car. It was called the *Grand Trunk Herald*, and had 400 or 500 subscribers at $1 a year. That's why I belong to the New York Press Club. In it I had all the railroad news and gossip and advertisements of my wares. The baggage master wrote the editorials. He is now one of the head men of the Grand Trunk system. I also had on this same baggage car a chemical laboratory. Then, in my desire to know everything, I began to read the public library of Detroit by shelves, beginning at the bottom on which stood the Encyclopedia Britannica. Every word of every volume of this I devoured, and then struck into the "Anatomy of Melancholy." But I had to give that up finally and then chose my books hit or miss.

The things I read and my boyhood experiences led me to get up a little machine shop shortly after I became an operator. Faraday did the rest, by turning my mind to the immense possibilities open in the application of electricity. I simply kept trying the work that gave me the greatest pleasure and satisfaction in the doing, without much thought as to where I was going to bring up.

### The Simplex Motor.

Among the new stationary motors that have appeared in the field as competitors of the older and better known types the one shown in the accompanying illustration presents in its general appearance a striking contrast to the ordinary direct current motors in general use. It has been brought out very recently by the Simplex Motor Company, of Boston, and has for some time been on exhibition at the company's office at 113 Devonshire street in that city. As will be seen from the illustration, the motor is a four-pole machine, the field magnets being placed on the interior of the armature. The cores project through the field coils so that the air space in the magnetic circuit is made as small as possible. The field coils are held in place by pins, as shown in the illustration. The number of armature coils is very large, and these are mounted, as will be seen, upon the exterior revolving frame. It will be noticed that the magnet frame is very compact, and the large diameter of the armature makes it possible to run at a speed much less, in the number of revolutions per minute,



THE SIMPLEX STATIONARY MOTOR.

than that ordinarily in use on the best known types of motors.

The same type of motor is adapted by the company to railway service, and is made in various sizes to suit the demands for different classes of work.

### Electrical Progress in Japan.

The Tokyo Electrical Society has appointed a committee of 15 to make investigations and publish some rules and regulations as standard requirements for electrical installations.

The telephone exchange of Tokyo City, Japan, in charge of the government, is very prosperous. The present number of subscribers is 320, while the population is 1,207,022, and the total number of houses 277,049. The Yokohama Exchange has 70 subscribers. Nearly all the telegraph and post offices have been combined and are now in a prosperous condition.

An electric elevator is running every day at Tokyo in a tower higher than the Times Building in New York City The current is supplied by the Tokyo Electric Light Company. The motor used is a 10 h. p. Sprague.

Experimental works are carried on at two or three different places in the Japanese Empire for refining copper by electricity.

### Magnetic Phenomena in Central Russia.

In a recent communication to the Académie des Sciences, General Alexis de Tillo calls attention to some remarkable local magnetic disturbances which occurred between the towns of Kharkov and Kourk. The area of disturbance is only about 22 miles from north to south by 15½ miles from east to west, and the following are the magnetic data for the principal centres of disturbance:

| Village. | Declination. | Dip. | H. | Total intensity. |
|---|---|---|---|---|
| Nepchaevo | + 48° west | +81 | 0.11 | 0.84 |
| Visloje | − 33° east | +52 | 0.40 | 0.65 |
| Kisselevo | − 38° east | +63 | 0.33 | 0.72 |
| Sobinino | + 30° west | +60 | 0 38 | 0.75 |
| Petropaoloko | − 20° east | +76 | 0.19 | 0.80 |

The greatest distance between the above-mentioned localities is not more than eight miles, and yet the declination varies by 86 degrees and the dip by 29 degrees. The normal values for this district are: Declination, one degree east; dip + 64 degrees; H 0.21; total intensity, 0.48. So far as the geological constitution of the soil is known, it gives no clue to the cause of the disturbance.

### Interior Conduit Company's Twin Conductor.

This conductor shown in the illustration is designed to fulfill the conditions of safety and reliability, and is claimed to have many important advantages, particularly when employed in combination with the same company's tubing. It is manufactured by the Interior Conduit and Insulation Company, of New York City. It is said that it costs

DOUBLE CONDUCTOR OF THE INTERIOR CONDUIT COMPANY.

less than two separately insulated wires of like quality and capacity, and that it can be placed in smaller space than most double conductors or any two separately insulated wires, and, therefore, permits of the practice of placing the containing tubes on the ceiling and side wall surfaces and then covering them with the ordinary plaster, thereby obviating the practice of running the tubes under the floors or behind the lath and plaster or of cutting channels in fireproofing. Its flexibility renders it easy to draw it in and out of tubing the diameter of which very closely approximates that of the conductor. The combination of the two conductors in one tube and in one strand materially lessens not only the cost of material but of the labor in any given installation.

This method of running conductors also affords an absolute guarantee that any fault that may develop at any time will result in a short circuit and the blowing of the safety fuse.

A full and careful study of the theory of the safety catch will, we venture to suggest, cause their ideas, as exemplified in this dual conductor, to be approved and accepted by all intelligent wiring men, notwithstanding the fact that the too ready short circuiting of their earliest make of twin wires has created some little prejudice against it by superficial thinkers. They have now removed these minor faults, and realize in their new wire the full practical application of their early theory, which is conceded by the highest authorities to be sound in principle.

### Cheap Electric Measuring Instruments.

Many institutions are to-day displaying the keenest interest in electrical science, and are endeavoring, in so far as their facilities permit, to give instruction in practical electricity. One of the difficulties that has to be met in arranging courses for institutions, particularly where there are large classes, is that of obtaining the necessary instruments without expense so great as to decidedly limit the equipment that can be provided. Until very recently there has been little between the extremely costly and elaborate instruments for exact measurements and cheap makeshifts that are unworthy a place in any reputable laboratory. The con-

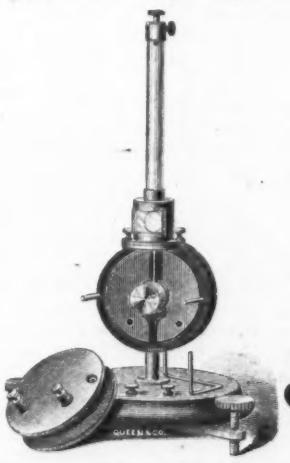


FIG. 1.—DEAD BEAT GALVANOMETER.

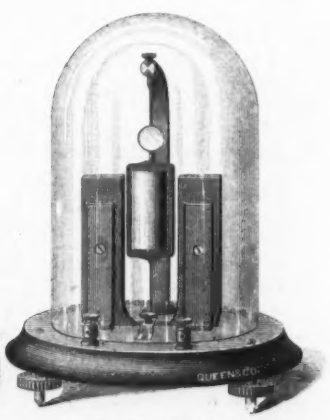


FIG. 2.—D'ARSONVAL GALVANOMETER.

tinued demands for instruments, however, has changed all this, and now there are manufactured in this country and elsewhere electrical apparatus for schools and commercial work that is at once low in price and excellent in quality. In this country Messrs. James W. Queen & Co., of Philadelphia, have recently made a specialty of this class of work, and have turned out quite a number of very satisfactory pieces of apparatus, some of which we illustrate herewith. No. 1 shows a dead-beat reflecting galvanometer, such as finds a wide employment in Wheatstone bridge work and general laboratory operations. The two coils, which are readily slipped out of position, if necessary, may be connected in series or in parallel, and completely inclose the magnet, which is bell-shaped and inclosed in a heavy block of copper fixed in the central fork. The mirror is attached to the magnet by a short, rigid suspension, and both are suspended by a silk fibre, with all necessary adjustments. A great convenience of this instrument is the ability to remove the copper damping block, thus making the instrument ballistic and exceedingly serviceable for magnetic measurements, determination of condenser capacity, and similar work. It thus makes an efficient all-round instrument without being particularly sensitive.

For work requiring extreme delicacy, especially for very exact bridge measurements, a cheap form of the Deprez-D'Arsonval reflecting galvanometer has been devised. This instrument, as is well known, employs the principle of coils suspended in a powerful magnetic field obtained from permanent magnets. It is extraordinarily sensitive, and almost absolutely dead beat. The form illustrated is very simple, and must prove of great use in ordinary laboratory measurements.

Another innovation that will be acceptable to most laboratories is a cheap reading telescope for use with either of these instruments. For some classes of galvanometer work the ordinary lamp and scale method of reading is sufficient, but for many measurements most observers prefer the more accurate method of Poggendorf. A cheap reading telescope is, therefore, a great convenience to laboratories, as it enables a large number of instruments to be equipped instead of spending as heretofore a considerable amount for one or two foreign-made telescopes of indifferent quality. The fourth instrument, especially adapted for students' use, is a combined tangent and sine galvanometer. The brass ring is 13¼ inches in diameter. The compass-box is arranged especially for laboratory use, and can be raised or lowered, rotated on its axis, shifted out of the plane of the coil and otherwise varied in position to exercise the student in the general theory of the galvanometer. For the same purpose the instrument can be turned about a vertical axis and the amount of deflection can be determined by a quadrant on a base graduated to degrees, so that the instrument can be readily used as a sine galvanometer. The needle is fibre suspended, and the windings supplied by the instrument are intended for the measurement of rather small currents,

FIG. 3.—READING TELESCOPE, STAND AND SCALE.

FIG. 4. COMBINED TANGENT AND SINE GALVANOMETER.

such as are generally derived from batteries. These four examples give an excellent idea of the class of instruments which are now available for laboratory equipment or private experimenters.

# Financial Intelligence.

## THE ELECTRICAL STOCK MARKET.

**Active.**—A bank statement showing an increase of $2,655,275 in surplus reserve, notwithstanding heavy gold shipments abroad, was a feature of Saturday. Stocks on the New York Exchange were off a trifle at the close, but the week winds up probably the most active in stock operations of any for months past. The general list has shown good advances for the week, and brokers are commencing to be in good spirits again.

**The Bond Market** is showing great activity, and good bonds on electric railways are finding a ready market. Bonds covering proposed or existing electric railroads in cities of 40,000 inhabitants and over, other conditions being satisfactory, are not going begging, as they were a few months ago.

**Money a Trifle Tight in London.**—The cable announced money rather higher and street discounts up to three and a half per cent. London, however, was a purchaser here, and the report of money tightness created little or no effect.

**Bell Telephone.**—We have in these columns continually advised the purchase of Bell Telephone stock at figures ranging close to 200. The correctness of the suggestion has been shown before, and is now again apparent. A few weeks ago the stock could be had below 200; Saturday night it closed at 206 bid, 206½ asked. The output of telephones for the month ending April 20, 1891, was as follows:

BELL TELEPHONE OUTPUT.

| Month ending April 20, 1891: | 1891. | 1890. | |
|---|---|---|---|
| Gross output | 6,413 | 6,062 | Inc. 351 |
| Returned | 3,278 | 1,892 | Inc. 1,386 |
| Net | 3,135 | 4,170 | Dec. 1,035 |
| Since Dec. 20: | | | |
| Gross output | 22,367 | 18,881 | Inc. 3,486 |
| Returned | 12,839 | 8,042 | Inc. 4,797 |
| Net | 9,528 | 10,839 | Dec. 1,311 |

**Detroit Electric Stock.**—The certificates of this company made their appearance on the Boston Exchange in the unlisted department during the week, and were in demand. This stock will hereafter be quoted regularly in our weekly report. The earning capacity of the Detroit company as compared with the other large electric companies compares as follows:

| Capital stock. | Name of company. | Earning capacity. |
|---|---|---|
| $10,000,000 | Thomson-Houston | $10,500,000 |
| 12,000,000 | Edison | 8,000,000 |
| 7,000,000 | Westinghouse | 5,000,000 |
| 1,000,000 | Detroit | 3,000,000 |

A Boston syndicate is reported to have taken a half million of the stock. The company has increased its capital stock from $500,000 to

$1,000,000. Par of stock, $10. From 1884 to 1888 the company paid cash dividends, and from 1888 to the present dividends were paid in stock, profits going into the plant. It is intended to double the size and capacity of the works, and when these improvements are completed, say in three months, gross business per annum is estimated at from $3,000,000 to $4,000,000.

The balance sheet struck April 7 presents the following statement:

ASSETS.

| | |
|---|---|
| Patents and inventions | $148,816 |
| Patterns | 8,117 |
| Machinery and tools | 69,842 |
| Furniture and fixtures | 8,899 |
| Bonds at 90 | 21,600 |
| Railroad stocks at 90 | 21,185 |
| Cash | 4,532 |
| Bills receivable | 55 000 |
| Accounts receivable | 120,115 |
| Unfinished contracts | 30,951 |
| Merchandise | 103,071 |
| Total | $592,133 |

LIABILITIES.

| | |
|---|---|
| Capital stock | $500,000 |
| Bills payable | 40,240 |
| Accounts payable | 51,892 |
| Total | $592,133 |

The proceeds of sale of stock to the syndicate will be applied to accounts payable, and about $100,000 to enlarging the plant, leaving $300,000 working capital. The stock of the company is placed only temporarily in the unlisted department, it being the intention of the company to have the stock on the "regular" list. The listing of the Detroit Company's stock on the exchange is a wise move on the part of the directors. Let other strong companies follow their example and they will find themselves bettered by so doing.

**Thomson-Houston.**—A computation of the earnings of the Thomson-Houston stocks has been made. The showing is very satisfactory from the investor's point of view.

| | Amount. | | Earnings. |
|---|---|---|---|
| Accounts and notes receivable | $8,257,916 | at 6 per ct. | $495,475 |
| Local stocks and bonds at | 1,992,550 | at 7 per ct. | 139,479 |
| Manufacturing Co.'s stock at cost. | 3,821,017 | at 6 per ct. | 229,261 |
| Construction Co. stocks at cost | 1,002,500 | at 20 per ct. | 200,510 |
| United Securities Co. stock at cost | 487,425 | at 9 per ct. | 43,868 |
| Total | $15,561,408 | | $1,108,593 |

In the above the accounts and notes receivable are taken at their face value and computed at the minimum interest, although a majority of the accounts will rule at seven and eight per cent. Local stock and bonds are taken at 40 and 70 per cent. respectively of their face value. Upon this valuation the item is earning more than seven per cent. Manufacturing Company's stocks are earning six per cent. on their cost. Though the Brush and other companies keep their earnings for development, the Fort Wayne alone pays the Thomson-Houston $120,000 per annum in dividends. Twenty per cent. on the Construction Company's stocks is a conservative estimate, and it should be considerable more this year. The United Securities stock is paying six per cent. dividends upon the $750,000 stock owned by the Thomson-Houston Company, which is fully nine per cent. upon its cost.

**To List United Electric Securities Company Bonds.**—The bonds of the United Securities Company are soon to be listed at the Boston Stock Exchange. The total issue is $1,000,000, and they are secured by $1,250,000 by first-mortgage of various electric light and power companies using Thomson-Houston apparatus.

**Westinghouse.**—We have always believed in the Westinghouse Company's ability to pull out of their difficulties, but we are of the opinion that if there is any correctness in the report of Mr. Westinghouse's success in raising money desired for his company it should be regularly given out, and not be in the air as a rumor which no one stands responsible for. Give the public the benefit of the information and the stock will go higher. F. Z. M.

**F. Z. Maguire & Co.,** electrical securities, 18 Wall street, New York, send the following closing quotations of Electric Stocks, on Saturday, April 25, 1891, in New York, Boston, Washington and Pittsburgh:

| Name of Stock. | Par. | Capitalization. | Bid. | Ask'd. |
|---|---|---|---|---|
| NEW YORK. | | | | |
| Western Union Telegraph Co | 100 | 86,200,000 | 82⅝ | 82¾ |
| American Telegraph & Cable | 100 | 14,000,000 | 83 | 85 |
| Central and South American | 100 | 5,000,000 | 145 | 160 |
| Mexican | 100 | 2,000,000 | 205 | 220 |
| Commercial Cable Co | 100 | 7,716,000 | 105 | 106⅛ |
| Postal Telegraph Cable | 100 | 5,000,000 | 39 | 41 |
| Edison General Electric Co | 100 | 9,503,500 | 98 | 99 |
| Consolidated Electric Light | 100 | 1,929 400 | .... | .... |
| Edison Electric Illuminating Co | 100 | 2,567,800 | 76 | 78 |
| United States Electric Light | 100 | 1,500,000 | 30 | 31 |
| North American Phonograph | 100 | 6,200,000 | .... | .... |
| BOSTON. | | | | |
| Thomson-Houston Electric Co | 25 | 6,000,000 | 47¼ | 48 |
| " " preferred | 25 | 4,000,000 | 25¾ | 25⅞ |
| " " Series C | 10 | 400,000 | 9 | 9¼ |
| " " Series D | 10 | 120,000 | 7⅛ | 7¾ |
| " International Co | 100 | 1,000,000 | .... | .... |
| Thomson Welding Co | 100 | 1.000,000 | .... | .... |
| " European Welding Co | 100 | 1,000,000 | 55 | 60 |
| Ft. Wayne Electric Co | 25 | 4,000,000 | 13¼ | 13½ |
| Westinghouse Electric Mfg. Co | 50 | 5,000,000 | 13⅝ | 13⅞ |
| Detroit Electrical Works | 10 | 1,000,000 | 13¼ | 13½ |
| Telephone: | | | | |
| American Bell | 100 | 12,500,000 | 206 | 206½ |
| Erie | 100 | 4,800,000 | 49 | 50 |
| New England | 100 | 10,504,600 | 50½ | .... |
| Mexican | 10 | 1,280,000 | 95c. | 99c. |
| Tropical American | 10 | 400,000 | 85c. | 95c. |
| MISCELLANEOUS. | | | | |
| Edison Phonograph Doll | 10 | 1,000,000 | .... | 1 |
| WASHINGTON. | | | | |
| Pennsylvania Telephone | 50 | 750,000 | 25 | .... |
| Chesapeake & Potomac | 100 | 2,650,000 | *57 | 65 |
| American Graphophone | 10 | 600,000 | 5¼ | 7 |
| United States Electric Light (Washington) | 100 | 300,000 | 175 | 185 |
| Eckington and Soldiers' Home Electric Ry | 50 | 352,000 | 55¼ | 57 |
| Georgetown and Tennallytown | 50 | 200,000 | 63 | 65 |

*Ex dividend.

**Chicago Quotations.**—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone and electric light stocks as follows:

| | | | |
|---|---|---|---|
| Chicago | $225@$245 | Cumberland | $60@ $62 |
| Central Union | 56@ 57 | Wisconsin | 118@ 120 |
| Michigan | 85@ 86 | Bell of Missouri | 160@ 165 |
| Great Southern | 30@ 32 | Iowa Union | 20@ 22 |
| Colorado | 34@ 36 | Missouri and Kansas | 54@ 56 |
| Rocky Mountain Bell. | 40@ 43 | | |

ELECTRIC LIGHT STOCKS.

| | | | |
|---|---|---|---|
| Chicago Arc Light and Power | $105@$106 | Chicago Edison Co | $145@$150 |

## AFFAIRS OF THE COMPANIES.

**The Lowell Electric Light Company** has issued a semi-annual dividend of $3.50 per share.

**The Detroit Electrical Works,** of Detroit, Mich., has increased its capital stock from $500,000 to $2,000,000.

**The Medina (N. Y.) Gas Company** has purchased the local electric light plant and will fill the latter company's contract with the town.

**The Eau Claire (Wis.) Light and Power Company** has been bought out by the Street Railway, Light and Power Company of Eau Claire.

**The Bay County Electric Light Company,** of Bay City, Wis., and the Home Company, of West Bay City, Wis., have consolidated to reduce expenses and get along with a single set of officers.

**The Lakeport, Saratoga and Ukiah (Cal.) Telephone Company** has been incorporated with a capital stock of $50,000. The principal place of business will be at Ukiah. The purpose is to construct a telephone line 40 miles in length, from Lakeport to Ukiah. Directors: J. Connor, Sampson B. Wright, R. H. Warfield, Samuel Wheeler and G. W. Crichfield.

**The Incandescent Light and Power Company,** of Norwalk, O., held its first meeting last week, and organized by electing the following officers: President, D. H. Fox; vice-president, D. C. King; secretary and treasurer, Charles Suhr. The directors are: D. H. Fox, E. D. Sawyer, Thomas Dunmore, D. C. King, W. E. Sidnell, D. W. Vail and Charles Suhr.

**The Edison Electric Illuminating Company,** of Lancaster, Pa., has published the following statement, showing the condition of the company in May, 1889, and January, 1891: May, 1889: Authorized capital, $170,000; stock issued, $132,500; assets, $170,105.95; and liabilities, $170,105.95. January, 1891: Assets, $188,075.70, and liabilities the same. Net earnings for past year, $27,234.51.

**The Brooklyn (N. Y.) Electric Light and Power Company** held its annual meeting for the election of directors and officers last week. The directors are: Thomas Black, Stephen J. Burrows, Charles A. Smylie, Theodore Dow, Edward S. Seeley, Henry H. Downes, Adolphe E. Smylis, E. Smith Newins, and Augustus P. Avery. The directors elected the following officers: President, Chas. A. Smylie; Vice-President, Stephen J. Burrows; Secretary, Thos. Black; Treasurer, A. E. Smylie; Manager, Chas. A. Smylie.

**The Brooklyn (N. Y.) Electric Light and Power Company** held its annual meeting for the election of officers, directors and inspectors of election, last week, resulting as follows: Directors, Thomas Black, Stephen J. Burrows, Charles A. Smylie, Theodore Dow, Edward S. Seely, Henry H. Downes, Adolphe E. Smylie, E. Smith Newins, Augustus P. Avery. The following are the officers: President and general manager, Charles A. Smylie; vice-president, Stephen J. Burrows; secretary, Thomas Black; treasurer, Adolphe E. Smylie.

**The Oil City (Pa.) Electric Company,** with a capital stock of $150,000 and $120,000 issued, was organized last week at a meeting of the stockholders held at the Pittsburgh office of the Western Electric Company. The following officers were elected: President and treasurer, Alex. Hamilton, of Pittsburg, Pa.; secretary, W. J. Breene, of Oil City; directors, C. A. Brown, of Chicago, Leo. A. Weil, of Pittsburg and J. G. Kaelber, of Rochester, N. Y. J. H. Payne will be superintendent of the plant and will assume the management in a few weeks, and it is expected that within another month or six weeks the plant will be in operation.

## NEW INCORPORATIONS.

**The Newmarket (N. H.) Electric Light, Power and Heat Company** has been incorporated.

**The Ashuelot Electric Light, Heat and Power Company,** of Ashuelot, N. H., has been incorporated.

**The F. B. Morgan Power and Light Company,** of Cincinnati, has been organized, with a capital stock of $10,000.

**The Franklin (Pa.) Electric Company** has been organized, with W. J. Bleakley, president, and James Miller, secretary; capital stock, $25,000.

**The Monticello Electric Light Company** has been incorporated to furnish electric light, power and supplies; capital stock, $10,000; incorporators, William F. Lodge, William E. Smith and Richard F. Platt.

**The City Electric Light Company,** of Charlestown, W. Va. has been incorporated. The incorporators are: Cleon Moore, B. D Gibson, Wm. Campbell, Wm. Neill, P. C. Kennedy and T. C. Greenall of Charlestown.

**The Watkins (N. Y.) Electric Light and Power Company** has been formed. Messrs. Chas. E. Taber, A. A. Couring and J. H. Drake are the organizers. It is proposed to furnish both street and private lighting.

**The Neihart (Mont.) Electric Light and Power Company** has been incorporated, with a capital stock of $20,000, to establish a plant to furnish electric light and power to Neihart and the immediate surroundings.

**The Texarkana (Ark.) Light and Power Company** has been incorporated by Mr. J. Deutschman and other prominent citizens to purchase and operate an electric light plant. The capital stock of the company is $125,000.

**The Western Water and Electric Light Company,** of McPherson, Kan., has been incorporated, with a capital stock of $25,000, to erect and operate water works and electric light works, and furnish steam and electric power.

**The Ennis (Tex.) Electric Light Company** last week was organized, with J. Baldridge, president; J. Blakey, vice-president; M. Latimer, secretary and treasurer; directors, L. A. Daffan and Peter Freeman, of Ennis, and O. J. Gorman, Wm. Endees, W. J. Williams and E. H. Shaumm, of Dallas.

**The Arnold Electric Manufacturing Company,** of Chester, Pa., has been incorporated for manufacturing electrical appliances. The capital is $50,000. Directors are: George N. Crumback, James C. Burton, Philadelphia; John B. Roach, William S. Blakely, William C. Gray, Chester.

# Special Correspondence.

## NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, April 27, 1891.

**Mr. Wm. B. Vansize,** electrical patent attorney, has removed his offices to the new Edison building on Broad street.

**The Edison Scientific Club** has been formed at Schenectady, N. Y., for the purpose of furthering the interest in the electrical sphere.

**The Metropolitan Telephone and Telegraph Company** had a hearing on the question of dissolving the injunction held by it against the city, but as yet the decision is reserved.

**The Charles Munson Belting Company,** through Mr. F. W. Baugher, has sold the new Overland Cotton Mills, of Denver, Colo., over 35,000 feet (about six miles) of its belting in widths from 1¼ up to 20 inches.

**Messrs. Chas. Paine & Sons** have opened new and commodious offices at 71 Broadway, New York, as consulting and civil engineers. Especial attention will be given to electric railway, electric mining and light and power plants.

**New Electric Club Members.**—Among recently elected members are: Dr. E. R. Chabbourne, Charles T. Hughes, George W. Silsbey, W. G. Whitmore, Duncan C. Robertson, Samuel H. Pine, W. K. Stern and George L Colgate.

**Mr. W. L. Boyden,** Treasurer of the H. E. Swift Manufacturing Company, of Boston, was a visitor to New York last week. To Mr. Boyden's business ability and tact a good share of the present prosperity of this lively young company is due.

**The Pacific Electrical Storage Company,** of 118 and 120 Pine street, San Francisco, Cal., has taken the Pacific Coast agency of the Walker Electric Company, of New York, and will carry a full stock of electrical meters, ammeters and volt meters.

**Mr. E. H. McFall,** formerly southern agent for the Eddy Electric Company, and now a member of the New Orleans Board of Fire Underwriters, giving his attention especially to electric lighting, has been in New York visiting old friends for the last few days.

**The Fall River (Mass.) Street Railway Company** is about to apply to the Massachusetts Legislature for permission to equip its road electrically. Thomas Murray & Co., of New York, have drawn the plans and will do the work if permission is obtained.

**Mr. Franklin E. Huntress,** representing the Wrought Iron Casting Company, of Boston, was in New York last week. This company is manufacturing a superior quantity of castings from "mitis" iron, and its sales are becoming very large in the electrical field.

**Mr. E. S. Mendels,** formerly of the Universal arc lamp, has returned to the banking business, in which he was engaged for many years. His office is at 16 Broad street, and he will probably pay especial attention to electrical securities, particularly electric railway bonds.

**Mr. A. D. Newton,** General Manager, and M. E. Baird, General Agent of the Eddy Electric Company, were in New York during the last few days. Mr. Baird has just returned from a trip West. Business was never better with this company and the prospects are that it will run 24 hours a day within a short time.

**Electric Companies in the New Edison Building.**—The following firms have removed their offices to the new Edison building on Broad street, New York City: The Amsterdam Street Railroad Company, The Twin City Construction Company, The Winston-Salem Railway and Electric Company, and The Universal Arc Lamp Company.

**Mr. C. E. Bibber,** general manager of the Consolidated Electric Manufacturing Company, of Boston, was in New York last Saturday on the way to New England from a Western trip, which has been very successful. He secured one order alone for 30,000 sockets, and the Boston factory is now running nights to keep up with orders.

**The Phœnix Glass Company,** of New York, has on exhibition in its show windows two medals, one from the Philadelphia Industrial Exhibition for heavy cut glass and one from the Piedmont (Ga.) Exposition for fine glass goods in general. This company has just brought out some new patterns in electric light globes and shades that are very handsome.

**American Institute Committee.**—At the meeting of the American Institute of Electrical Engineers, held last week, the following local committee was appointed by President Anthony to co-operate with the secretary in perfecting arrangements for the annual and general meetings to be held in this city May 19, 20 and 21: H. A. Foster, Harold Binney, Thorburn Reid, Edward B. Ives and Edward Caldwell.

**The Field Engineering Company.**—Owing to rapidly developing business, especially during the last year, the Field Engineering Company removed Saturday, April 25, to its new offices, rooms 618, 619, 620 Central Building, Liberty and West streets, New York, where, with the increased accommodation, it is expected the company will be able to furnish estimates and arrange for the construction of electric railways with greater facility.

**The Early History of Electricity.**—The fifth social reunion of the American Society of Mechanical Engineers is to be held at No. 12 West Thirty-first street, this city, April 30. Mr. Park Benjamin will give a talk upon "The Allusions to Electricity Previous to Galvani." Members of the American Institute of Electrical Engineers will be welcome upon the same footing as the Mechanical Engineers, and may obtain cards of invitation by addressing R. W. Pope, secretary.

**Mr. W. S. Chelsey,** electrical engineer and broker, of 171 Broadway, New York City, reports the following recent sales: Two Westinghouse 750 alternating current dynamos and 1,000 light capacity in converters, one 50 light and one 3-light American dynamo, one 200-light United States dynamo and one 10-light Weston arc machine, also a number of motors. Mr. Chelsey has leased quarters in the new Electrical Exchange building, where he will exhibit a large line of samples of various makes of machines.

**Messrs. W. R. Fleming & Co.,** of 174 Fulton street, New York, have received during the past two weeks orders for some 15 Ide and Ideal engines, together with other contract work, among which are the following: One 500 h. p. Ide cross compound, New England Engineering Company, Waterbury, Conn.; one 75 h. p. Ideal, Pratt & Whitney, Hartford, Conn.; two 150 h. p. Ide tandem compounds, Somerville Electric Light Company, Somerville, N. J.; one 150 h. p. Ide tandem compound, Hackensack, N. J.; one 35 h. p. Ideal, Tarrytown, N. Y.; two 100 h. p. steel boilers with Weitmeyer patent furnaces, for Long Island City Electric Railroad; also four contracts for shafting and friction pulleys, manufactured by William Sellers & Company, and Moore & White Company, of Philadelphia. All of the above plants are equipped with the celebrated Jewell Belting, of Hartford, Conn., for which company they are also the agents.

**The Franklin Experimental Club,** of Newark, N. J., held its thirteenth annual meeting last week at its laboratory. The speaker of the evening was Francis R. Upton, who read a paper entitled "The Possibilities of Electricity." The speaker described his early experiences in the electrical field when he first became associated with the development of the incandescent lamp at Menlo Park. He declared that the growth of that industry in extent and efficiency, a growth with which his own business career was closely allied, made him feel prophetic in regard to the future. He stated that the incandescent electric light offered a most promising field for investigation. Mr. Upton then took up the sub

ject of heating and said that electricity was, theoretically, a perfect agent for the purpose; that it was even now possible to furnish electrically generated heat for domestic purposes, and that it only remained to so reduce the cost of producing heat electrically as to place it on a commercial basis. The speaker went into the subject of the generation and maintenance of power on a large scale; also, the advance being made in long-distance telephony. Mr. Upton brought his paper to a close with the prediction that New York would become the great electrical centre of the world, and that the city's growth and development would offer unprecedented opportunities for electrical expansion. A general discussion followed and was participated in by Messrs. Wm. J. Hammer, Geo. B. Webb and Dr. T. W. Corwin. Some novel incandescent lamp experiments were shown by F. W. Hillard and Paul H. Jaehnig. At the next meeting of the club, in May, a paper will be read by Wm. J. Hammer, entitled "The Arc Light."

**American Institute of Electrical Engineers.**—The following associate members were elected at the council meeting, April 21, 1891: Henry Alexander, electrical contractor, 340 West 145th street, New York City; Frederick Bedell, graduate student Cornell University, 118 Elm street, Montclair, N. J.; Turner D. Bottome, electrician and general manager White House Mills, Hoosick, N. Y; Frank Bourne, electrical engineer, the Field Engineering Company, 15 Cortlandt street, New York City; Chas. B. Borleigh, 620 Atlantic avenue, Boston, Mass.; Geo. D. Burton, president Electrical Forging Company, 194 Washington street. Boston, Mass.; Louis Casper, Wheatstone repeater chief, Western Union Telegraph Company, Cheyenne, Wyo.; Lewis M. Clement, 1,013 Central avenue, Oakland, Cal.; A. R. Cogswell, electrician and superintendent, Halifax Illuminating and Motor Company, Limited, 34 Bishop street, Halifax, N. S.; Gano S. Dunn, student in electrical engineering, Columbia College, 66 West Ninety-third street, New York City; Allan R. Foote, Special Agent, Electrical Industries, U. S. Census, Washington, D. C., P. O. box 432; Thos. H. Foote, 104 Columbia Heights, Brooklyn, N. Y.; Francis R. Hart, superintendent of construction Massachusetts Electrical Engineering Company, 4 P. O. square, Boston, Mass.; John C. Henry, electrical engineer, 114 E. 54th st., New York City; Herman S. Hering, professor of applied electricity, Phila. Manual Training School, 553 No. 16th st., Philadelphia, Pa.; Charles H. Herrick, manager and electrical engineer, Wright Electrical Engineering Company, 196 Summer st., Boston, Mass.; Franklin S. Holmes, electrical engineer, with C. H. Davis, 120 Broadway, New York, 445a Macon st., Brooklyn, N. Y.; A. Langstaff Johnston, civil and consulting engineer in the general construction of electric railways, 1,105 E. Main st., Richmond, Va.; J. R. Lovejoy, electrical engineer, Thomson-Houston Electric Company, 620 Atlantic ave., Boston, Mass.; Giacomo Schmidt, assistant general manager, Richmond Light, Heat and Power Company, New Brighton, N. Y.; Robert J. Sheehy, electrical engineer, Equitable Mfg. and Electric Company, 24 West st. and 101 W. 76th st., New York City; George D. Shepardson, Instructor in Physics, Cornell University, Ithaca, N. Y.; Hollon C. Spaulding, Sec'y Thomson-Van Depoele Electric Mining Co., 620 Atlantic ave., Boston, Mass.; F. M. Tottingham, supt. Second District, Edison Electric Ill. Co., 49 W. 26th st., New York City; Alexander Thompson, supt. Electrical Dept. and chief engineer Superior Water, Light and Power Co., West Superior, Wis.; Philip V. R. Van Wyck, Jr., 36 W. 12th st., New York City; Edwin S. Webster, Mass. Electric Engineering Co., 4 P. O. square, Boston, Mass. L. H. H

## NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, April 25, 1891.

**The Thomson Scientific Club** will hold its second annual banquet on May 13 at Lynn, Mass.

**Mr. J. Edward Wallace,** manager of the railway department E. E. S. & C. Co., left last week for an extended trip through the South.

**Mr. I. W. Colburn,** Fitchburg, is rushed with orders for his new dynamos and motors, and is building an addition to the factory to accommodate the increasing business.

**Messrs. J. E. Wilson & Co.** report the sale of an 80-h. p. engine to Whitman and Keith, of Campbello, Mass., and a 60 h. p. engine to James Means & Sons, of Brockton, Mass.

**Prof. Leonard Waldo,** of the Aluminium Brass and Bronze Company, of Bridgeport, Conn., gave a lecture before the Society of Arts last week on the subject "Aluminium and Its Alloys."

**The Fitchburg (Mass.) Steam Engine Company** is in receipt of some very good contracts for its celebrated engines, and is doing a good business generally throughout the country.

**Messrs. Pierce Brothers,** of Leominster, Mass., have been awarded the contract for the entire electrical equipment of the Worcester and Spencer electric railway, which is 12 miles long.

**Mr. R. W. Rollins,** recently district engineer of the New England department of the Westinghouse Electric Company, has accepted a position as assistant superintendent of the Hartford (Conn.) Electric Light Company.

**The Wainwright Manufacturing Company** has sold a 300-h. p. feed-water heater to the Schuyler Electric Light Company of Pottstown, Pa., one 200-h. p. heater to the Tyrone (Pa.) Electric Light Company, and one 150-h. p. heater to the Thomson-Houston Electric Company, Boston.

**The New England Telephone Employes' ball** netted a profit of $86, which amount was donated to a sick employé. The employés are organizing a mutual benefit society, membership to be limited to employés of the New England Telegraph and Telephone Company, and they are meeting with much encouragement.

**Mr. Geo. B. Davis,** recently connected with the Gothins Electrical Manufacturing Company, has been appointed the Boston representative of the Eastern Electric Light and Storage Battery Company, of Lowell, Mass., with an office at 606 Sears Building. The many friends of Mr. Davis will be pleased to know of his advancement.

**The Redding Electric Company** has elected Mr. Stanwood treasurer, vice Mr. Sherman L. Whipple, resigned. Harvey Redding has charge of general construction and installation, Jerome Redding has charge of the manufacturing, and H. M. Nichols will manage the purchasing, sales and office department. This company is now organized on a thoroughly business basis, and this action on the part of the company seems amply appreciated, as is evidenced by the rapid increase in orders already received.

**President Whitney on the Electric System.**—At a recent meeting, held at Cambridge, Mass., in the interests of rapid transit, President Whitney, of the West End road, said: "The company believes that it has developed the cheapest method of transportation in the electric system. It is your duty to co-operate with us. The cost of this system for March, notwithstanding the large cost of power, was four cents less per mile than by horses. We believe that when the power houses are finished the cars can be operated at a saving of six cents a mile. We believe this can be done with large cars, and this is where the benefit to the people comes in."

**The Russell Electric Company** gave an exhibition of its various lamps burning in circuit at the factory at Ballard Vale last week for the benefit of the electrical fraternity and others interested in the success of its new arc lamp. The party consisting of nearly 100 people, including a number of ladies, took the special cars provided from the Boston and Maine station. The comfort of the guests was looked after by Mr. A. W. Rounds, the genial president and general manager of the Russell company, and Mr. F. H. Carpenter, treasurer, and it is superfluous to add that their attention left nothing to be desired. The exhibition consisted of 25 lamps of various voltage and candle-power in one circuit, presenting a beautiful appearance. The lamps burned very smoothly with a very notable absence of the usual sputtering to be noticed with the burning of so many lamps in one room. After thoroughly viewing the lights the party were conducted through the various departments of the large factory of the company, which proved very interesting. Refreshments were then served and the party took the train for home. The consensus of opinion, especially among the practical electricians present, among whom was the veteran Warren S. Hill and Frank Ridlon, seemed to be that the Russell arc lamp was a decided success. C. A. B.

## PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
13 CITY TRUST BUILDING, PHILADELPHIA, April 25, 1891.

**Messrs. W. S. Griffith & Co.** have sold the Kenilworth Inn Company, of Asheville, N. C., two 300-light Mather dynamos as an addition to a plant they had previously installed.

**John R. Galloway,** of Washington, D. C., has been awarded the contract for electrical work at the New Chamberlin Hotel, at Old Point Comfort. The installation will include a Partrick & Carter Company's new patent return call and fire alarm annunciator of 600 numbers.

**Wilmington, Del.**—The Wilmington City Railway Company began a few days ago to erect poles on Market street to change its line on this street from horse to electric power. The company expects to be ready for the change by the latter part of June. George W. Stone is doing the work. Carolina sawed pine poles are being used.

**The Lock Haven (Pa.) Electric Company,** which has recently ordered another 1,000-light National alternating machine from Mr. C. M. Blanchard, of this city, now finds itself in need of more power to run the constantly increasing number of lights. Another boiler and Corliss engine are contemplated in the near future to fill the demand. Mr. Blanchard will put in a new line of shafting, friction clutches, etc., for the additional 1,000-light machine above mentioned. Mr. J. B. Baker has charge of the construction work. W. F. H.

## WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, April 25, 1891.

**The Sperry Electric Mining Machine Company** is removing its factory to 39th street and Stewart avenue, Chicago.

**The Elmer A. Sperry Company** has removed from 207 Canal street to Thirty-ninth street and Stewart avenue, Chicago.

**Cheyenne, Wyo.**—The large electric light plant at the Union Pacific Railroad car shops, of 2,530 lamps capacity, will start next week with 1,620 lamps in use.

**Colonel George B. Shaw,** General Manager of the National Electric Manufacturing Company of Eau Claire, Wis., was prominent in the National Convention at Cincinnati this week.

**The Electrical Construction Company,** 175 Randolph street, has just finished equipping the new Hebrew synagogue on Thirty-third street and Indiana avenue, with a complete electric gas lighting system for over 500 lights.

**The H. W. Johns Manufacturing Company,** 240 and 242 Randolph street, Chicago, was unfortunate in suffering a loss of about $1,000 worth of property through a fire this week. Fortunately the property was fully insured.

**Toledo, O.**—Mr. J. K. Tillotson has just closed an important contract for the electric light and electric railway for Put-in-Bay with Mr. A. Stuart, president of the Central Thomson-Houston Company, of Cincinnati, O. The total amount of the contract is $95.000, and the Thomson-Houston Company guarantees that the entire plant, including railway, shall be in full operation by June 25 next.

**Mr. H. M. Underwood,** the general Western agent of the Interior Conduit and Insulation Company, is well pleased with the excellent results shown in testing the interior conduit in the Dunshee apartment building, Chicago, which is one of the first apartment buildings in the West in which the conduit has been placed throughout in strict compliance with the specifications of the Interior company. The Electrical Construction Company, 175 Randolph street, has done all the work on this contract.

**The Sperry Electric Company,** 207 Canal street, Chicago, is building a new type of arc light dynamo having but two field coils within which revolves the Sperry type of Gramme armature, the output being controlled by the improved form of Sperry regulator. This is claimed to be one of the most efficient arc dynamos in the market and recent experiments would seem to justify that claim. The Sperry Company is also building a new type of multipolar generator for railway work, the first one of which is now in use at Pullman.

**The Columbian Exposition.**—There still remains a difference of opinion between the Department of Electricity and the Department of Construction as to the requirements of the electrical display. Prof. Barrett, Chief of the Department of Electricity, prepared and submitted to Director-General Davis a formal presentation of the case and requested that sufficient room be granted for a united electrical exhibit. The Director-General indorsed and referred the matter to Col. R. C. Clowry, chairman of the committee on electrical appliances, and that committee will take proper action on Monday afternoon. President Bonney has prepared a classification suggesting the months in which certain sections of the World's Congress shall meet, and has placed electricians in the month of July as follows: July 1, science, philosophy, invention and education, including congresses of teachers, superintendents of schools, astronomers, archæologists, botanists, chemists, electricians, ethnologists, geologists, geographers, mineralogists, metallurgists, zoologists, etc.

**Public Servants.**—The following statement of the salaries of officials and their assistants is copied from the pay roll of the city of Chicago. Fire department: Superintendent of city telegraph, $3,675; one chief operator, $2,362; three operators at $1,575 each; three assistant operators at $1,260 each; one chief of construction, $1,800; one battery man, $945; five repairers at $1,102.50 each; one chief of electric repair shop, $1,575; three linemen at $945 each; one machinist, $1,050; two assistant machinists at $756 each; one clerk and stenographer, $1,260. Police department: One chief operator telephone service, $1,300; one assistant operator telephone lines, $900; 85 operators police telephone at $720 each; four drivers for ambulances, at $720 each. F. DE L.

CINCINNATI, April 25, 1891.

**Mr. E. V. Cherry,** president of the Standard Electrical Works, Cincinnati, O., is attending the meetings of the State Board of Equalization at Columbus, O., of which board he is president.

**The Equitable Transportation Company,** of Chicago, in which Irus Coy, John B. Sherman and the Thayers, of Boston, are said to be interested, proposes to construct an elevated railway line south on Halsted street to Eighty-seventh street. This company, by the liberal terms of its ordinance, granted by the old town of Lake in 1889, appears to have the right to erect telegraph, telephone, electric and pneumatic appliances on all its various lines, and it is said that work on the same will begin immediately.

**Fighting the Gas Company.**—The Edison people are installing an extensive light and power plant. They have the best wishes of the citizens in their prospective fight with the Cincinnati Gas Company, which gives cheap and poor service in order to push electric lighting out of existence. Evidently there is more money in supplying gas than electricity. The installation of motors is going on rapidly even at the present high power rates. The fan trade, from the present outlook, is going to be immense this summer. C. E. R.

## SOUTHERN NOTES.

NORFOLK, Va., April 25, 1891.

**Glasgow, Va.**—The poles for the electric light wires are being planted.

**Huntsville, Ala.**—A new incandescent light is to be put in by the local electric light company.

**Hampton, Va.**—An iron and wooden bridge is to be erected by the Hampton and Old Point Electric Railway Company.

**Little Rock, Ark.**—The capital stock of the City Electric Street Railway Company has been increased to $500,000.

**La Grange, Tex.**—Bonds are to be issued for the erection of an electric light plant. For information apply to the Mayor.

**Greenwood, Miss.**—An electric light plant is to be put in the foundry and machine shop of the Ragsdale Manufacturing Company.

**Newman, Ga.**—The contract for the erection of an electric light plant has been closed by the National Electric Light Company.

**Charleston, W. Va.**—A franchise for the construction of an electric railway has been applied for by the People's Street Railway Company.

**Anniston, Ala.**—It is stated that the arrangements have been completed for changing the Anniston street railway to the electric system.

**Baltimore, Md.**—A proposition to light the city hall by electricity has been submitted by the Wenstrom Consolidated Dynamo and Motor Company.

**Talladega, Ala.**—A meeting is to be held on the 6th of May by the Talladega Gas, Light and Water Company for the purpose of increasing its capital stock.

**Lynchburg, Va.**—The electric street car line on Main street is being rapidly pushed forward to completion. The cars will be making their regular rounds by next week.

**Warrenton, Va.**—Mr. L. D. Bliss, of Washington, D. C., held a recent conference with C. W. Rosenberger as to the proposed electric plant for Warrenton and South Warrenton.

**Baltimore, Md.**—The Baltimore City Passenger Railway Company contemplates equipping part of its lines with the electric system, and is investigating the cost of the project.

**Richmond, Va.**—The mechanical department of the University of Virginia has recently been the recipient of a small dynamo from Mr. Edison. The department now makes its own light.

**Pamplin, Va.**—Mr. W. D. Thornton, of Pamplin, on the Norfolk & Western Railroad, has a contract for furnishing the Western Union Telegraph Company with 11,800 poles, which are to be shipped south.

**Middlesborough, Ky.**—Work has been begun on the new plant of the Electric Light, Heat and Power Company. The capacity of the present plant will be increased four times—3,000 incandescent and 800 arc lights.

**Asheville, N. C.**—J. G. White, of New York, has received a contract from the Asheville Loan, Construction and Improvement Company, for the construction of one and three-quarter miles of electrical street railroad.

**Mr. M. B. Leonard,** of Richmond, superintendent of telegraph for the Chesapeake & Ohio Railway, has recently purchased the electric light plant of the railway company of this city, and will continue to furnish the piers, etc., with light.

**Atlanta, Ga.**—At its last meeting the Board of Police Commissioners accepted the signal system which has been in course of erection since last October. The system was put up by the Fire Alarm Telegraph Company, of Boston, at a contract price of $10,000.

**Washington, D. C.**—The Chesapeake and Potomac Telephone Company will pay a dividend of 75 cents per share on the 27th day of April, 1891, to the stockholders of record at the close of business on the 17th day of April, 1891, at the office of the treasurer of the company, 619 Fourteenth street, N. W.

**Washington, D. C.**—The Potomac Electric Company has, by Joseph C. O'Gorman and Michael O'Donnell, of Stillwater, Minn., P. Gilbert, G. C. Hill, Jr., G. W. Laird and Neill Dumont, filed a certificate of incorporation. The object is to produce electricity for use as a motive power or illuminant. The capital stock is $25,000 in shares of $100 each, with privilege to increase to $500,000.

**Wilmington, N. C.**—Mr. E. L. Hawks, of Winston, and Mr. John H. Barnard, of Asheville, representing the syndicate which proposes to purchase and convert the Wilmington street railway into an electric railway, are in the city for the purpose of consummating their final arrangements for the purchase of the road. As soon as the details of the purchase are complete, the electric plant for operating the road will be put in with all the dispatch possible. V. N. B.

## ENGLISH NOTES.

LONDON, April 8, 1891.

**London-Paris Telephone Wire.**—Experiments continue to be made with this line. A few days ago London was placed in telephonic communication with Marseilles, which is more than 700 miles distant, and speech was found possible.

**Electric Traction at Bremen.**—The Bremen Tramway Company are so satisfied with the results of an experimental line

on the Thomson-Houston overhead system that they are now seeking powers for substituting electric traction for horses throughout their system.

**Electric Light for Coast Defenses.**—Classes have been opened at the School of Military Engineering at Chatham for the instruction of officers and men of the Royal Artillery in the manipulation of electric lighting and electrical machinery generally. The first class has been taken from the garrison at Portsmouth.

**Electric Launches on the Thames.**—Hitherto practically the only firm which has catered for the public demand for electrical launches has been Messrs. Immirch (now the General Electric Power and Traction Company). Messrs. Woodhouse & Rawson, however, now propose to enter the lists, and have commenced the construction of electric launches and the erection of the necessary charging stations on the banks of the Thames.

**The Electric Lighting of the British Museum.**—The electric lighting of the British Museum, which was inaugurated with considerable éclat some 12 months ago, has not proved as great a source of attraction as was anticipated. This, however, is not surprising, as not only is the lighting carried out in a very partial and perfunctory way, but the public seeking instruction at the museum are turned out in a summary manner at dusk and readmitted after eight. It would argue something more than ordinary scientific enthusiasm for the average individual to cool his heels outside the portals of the British Museum for three or four hours on a foggy November evening, waiting for the door to be reopened and the electric light switched on. It is needless to say that endeavors are being made to show that the electric light is a costly failure.

LONDON, April 15, 1891.

**The London-Paris Telephone Line.**—The French papers report that on the opening day of this line the number of speakers in Paris only amounted to 22. The average number of conversations now amounts to about 50 per diem. Should this be maintained for the first 12 months the handsome income of $6,000 will be realized. The line is being largely used by news agencies, who have found it possible to get through a conversation of 300 words in the three minutes allowed.

**Agitation for Improved Telephone Service in London.**—I mentioned some little time ago that there was a movement on foot in the metropolis tending to the formation of a telephone association for securing a cheaper and more efficient service than is at present provided. A public meeting of the supporters of this movement is to be held this afternoon, and it will be interesting to see exactly how it is proposed to proceed. The running of a rival exchange is almost out of the question, and agitation and threats of "boycotting" seem unlikely to lead to much result.

**Bristol.**—As I have previously informed you, the municipal authorities of the city of Bristol, one of the four chief ports of the United Kingdom, acting on the advice of Mr. Preece, have at last decided to avail themselves of the powers granted to them under their provisional order of 1883, and to erect a municipal central lighting station at a cost of £60,000. An admirable site has been secured, and Mr. Preece, assisted by Mr. Gisbert Kapp, will no doubt succeed in making the Bristol central station a model one of its kind. Bristol being a large and somewhat scattered city, the alternating system will of course be adopted. In addition to the private lighting, it is proposed to light several of the main streets with arcs arranged some 80 feet apart.

**The Operations of the Mutual Telephone Company.**—The Mutual Telephone Company, which opened an exchange in Manchester some few weeks ago in opposition to the National Company, seems to be meeting with general favor. It is now sending round a list of testimonials received from the more important of its subscribers, all of which speak in high terms of the promptness of the communication and the clearness of speech, as well as absence of disturbance. "In considering these testimonials it should be remembered," the company remarks, "that they refer to a service which was declared to be impossible until after the lapse of the Edison patent next July, and that the service, good as it already is, will be remarkably improved when the use of carbon, now prohibited, becomes free toward the close of the month named."

**Postmaster-General and the Boy-Messenger System.**—As I wrote you some few weeks ago, the Postmaster-General, in virtue of the monopoly conferred upon him by the Post Office and Telegraph Acts, recently instituted legal proceedings against the messenger companies, who were inaugurating a system of boy messengers and electrical calls similar to those in vogue in the United States. Rarely has the action of any government aroused such a chorus of indignation as this step. The daily papers outvied each other in attacking the Postmaster-General. Members of Parliament nightly tormented him with uncomfortable questions, and the *Times* brought out its long discussed thunder for the occasion. The Postmaster-General, however, apparently remained obdurate, the legal proceedings were continued, and a rival service was brought into existence by the Post Office. But in the end public opinion has gained the day. The companies, having made a formal acknowledgment of the exclusive rights of the Post Office, have now been granted full license to carry on their useful work.

**The National Telephone Company and the City Authorities.**—The petition of the National Telephone Company to be allowed to take up the pavements in the city for the purpose of laying underground wires has been indefinitely shelved. The engineer to the corporation reported that in his opinion it would *not* be advisable to allow that company to disturb the streets, and that the whole question of electrical wires would have to be considered in connection with a complete system of supply mains. The subcommittee to which this report was addressed were not so entirely averse to the disturbance of the streets, and recommended that the company should be allowed to lay its wires *in the same conduits* as those about to be laid in connection with the lighting of the city. The electric lighting companies concerned wrote, however, that such a proposition required grave consideration before being carried into effect, and in consequence of this protest the matter has been practically shelved. So that once more the National Company has been baffled in its endeavors to get its wires underground.

## Answers to Correspondents.

*Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.*

**Edison Carbon Telephone.**—Will you tell me whether Mr. Edison controls patents on his carbon telephone transmitter in America and Europe? A. F. B.

The American Bell Telephone Company controls Mr. Edison's telephone patents in this country and abroad.

**Magnetic Shield.**—Will you kindly answer the following questions? (1) What constitutes a magnetic shield? (2) Why is it important to keep both sides of an Edison three-wire system as early balanced as possible? (3) What is meant by commutating a motor field? M. J. S.

(1) A tube of diamagnetic metal, such as copper, which surrounds the iron core of an induction coil is sometimes called a magnetic shield. The presence of this tube diminishes the inductive action of the magnetism of the core upon the secondary coil. "Magnetic shields for watches" are advertised. These last are made of iron; the idea of protection being that the lines of force will be shunted away from the interior of the watch by means of the permeable path of the iron case which surrounds the watch. But there is no substance which completely shields from magnetism. (2) It is necessary to keep both sides balanced in order that the drop in one side may not be large enough to disturb the difference of potential between the two sides. (3) In some railway motors, notably the Sprague, the field-winding is divided into several separate coils. The number of coils in circuit at one time determines the strength of the field, and the regulation by cutting in or out a number of these coils is called commutating a field.

**Electric Traction with Primary Cells.**—The writer has seen described a cell which is said to have no local action and no polarization, and which seems to be an excellent cell generally. The dimensions are: $4 \times 12 \times 12$ inches. It has two volts pressure, .03 ohm resistance, and on short circuit a current of 66 ampères. Its capacity is claimed to be 300 ampère hours. The cost of zinc is seven cents per horse power hour, and the cost of the depolarizer is two-thirds that amount. Could not such a battery cell compete with horse power on street cars? B. J. W.

No. Even though the cell described is as good a one as might be obtained, a primary battery cell of any efficiency whatever cannot compete with horse power for street car work. To develop the necessary horse power for the propulsion of a car would probably require as many as 250 cells, if not more. Again, there is no cell which has no local action or no polarization. Attempts to run street cars by primary battery cells arise either from ignorance or knavery, or both.

# News of the Week.

## THE TELEGRAPH.

**St. Paul, Minn.**—The Western Union Telegraph Company has at last agreed to the order of the city authorities, and will place its wires under ground at once.

**Miss L. V. Burrill,** the manager of the Commercial Union Telegraph Company's office at Newburyport, Mass., has accepted a position with the same company at Gardner, Me.

**Movement of Trains by Telegraph.**—A committee appointed by the Train Dispatchers' Association met in Chicago last week to consider the Lynn convention code of rules for the movement of trains by telegraph. After going over the rules carefully the committee will draw up a report recommending whatever changes it may decide upon. The report will be submitted to the next convention of the association, to be held at Toledo, June 16.

## THE TELEPHONE.

**Old Orchard, Me.,** is taking decided steps to establish a local telephone system. The Old Orchard Improvement Society has collected funds for that purpose.

**Pickens, S. C.**—Mr. J. E. Boggs is at the head of a company formed to establish a telephone system connecting the towns of Pickens, Easley and Greenville.

**Asbury Park, N. J.**—The aldermen have ordered the New Jersey Telephone Company to remove its poles within 60 days because the latter will not give 10 telephones for the free use of the corporation.

**The Massachusetts Pulsion Telephone Company,** through its Connecticut agency, has put in over 20 lines during the past two weeks. The West End Street Railway, of Boston, is now using 13 of these lines where a general connection is not needed.

**Long-Distance Telephoning in California.**—The telephone line between Sacramento and Stockton, and which connects at Galt, was completed last week, and conversations have been had over the new wire. The tones of the voice were clearly heard at either end of the line.

**Nebraska City, Neb.**—A short time ago the Nebraska Telephone Company proposed to extend its line from Dunbar to Nebraska City for a small bonus. The requisite amount has been subscribed and the line will be built in the near future. This gives Talmage direct telephonic communication with Nebraska City, Lincoln, Omaha and other points.

**Mr. Benjamin F. Lloyd,** for the past three years assistant general western manager of the United Press in Chicago, has resigned his position to accept that of State superintendent for Indiana, for the Central Union Telephone Company, with headquarters in Indianapolis. Since he has been located in Chicago he has had charge of the preparation and forwarding of news for the West.

**The Belleville (Mo.) Telephone Company's** office has been established eight years last week. Mr. E. A. Woelk has been the manager since the office was opened with 24 telephone subscribers. There are now 180 instruments in use, with many miles of wire stretched out over the city. The office does a good business. Manager Woelk recently went to St. Charles, Mo., where he will superintend the opening of a new office, which will be under his management.

## THE ELECTRIC LIGHT.

**Broken Bow, Neb.,** is to establish an electric light plant.

**Uniontown, Ala.,** has issued $125,000 in bonds for the erection of an electric light plant.

**Livermore, Cal.,** has advertised for bids for an electric arc light plan of 12 lights capacity.

**St. Ignace, Mich.,** wants an electric light plant, and is making estimates upon an installation.

**Kalamazoo, Mich.**—Three hundred lights are being added to the plant of the Kalamazoo asylum.

**The Bath (Me.) Iron Works** is to have a large isolated plant to furnish its own electric lights.

**Roseland, Ill.,** is making efforts to establish a company for the purpose of installing an electric light system.

**Staunton, Ill.,** City Council has granted a five years' franchise for an arc light plant to Mr. E. Friedman.

**Rutland, Vt.**—The city trustees have awarded the contract for street lighting to the Rutland Electric Light Company.

**Pueblo, Col.**—The city council held a meeting last week and granted the Pueblo Electric Company a 25 years' franchise.

**Tacoma, Wash.**—Mr. Henry Hatton has been granted a franchise to place electric lines for electric light and power purposes.

**Arcola, Ill.**—Ex-mayor Woodworth and Mr. Albert Lyde have been awarded the contract for installing an electric arc light station.

**Alexandria, La.**—Messrs. C. A. Vaniman and F. M. Welch are arranging to organize a stock company to erect a local electric light plant.

**Gilroy, Cal.,** last week granted a franchise for a local electric light plant to F. W. Swanton, of Santa Cruz., to be in operation not later than Oct. 1 of this year.

**Marshall, Tex.**—The municipal electric lights will be run until Sept. 5, and if the working proves economical the city will continue to use electric light.

**Chehalis, Wash.**—Mayor Millet has closed the contract with the two local electric light companies. Lights are to be put in within 30 days after approval.

**Bridgeport, Ala.**—Messrs. A. L. Soulord, E. A. Hoffman, Jr., F. L. Kilpatrick and others have organized a company to erect an electric light plant. The capital stock is $60,000.

**Owosso, Mich.**—A franchise has been granted the Owosso Electric Light Company to run its wires to Coruna, Mich., for the purpose of lighting that city. Work will commence at once.

**Venice, Ill.**—The Niemann Electric Light Company has secured a location for its plant opposite the Town Hall. The plant will cost about $12,000, and the work of installation will begin at once.

**Winona, Minn.**—Work at the new plant of the Winona Electric Light Company is being pushed rapidly forward, as it is the expectation to remove from the water-works building about April 16.

**Easthampton, Mass.**—The local gas company has been granted the power by the electric light commissioners to furnish electric light and power in the city. The company is to be equipped within six months with a capacity of 40 lights of 1,800 c. p. each.

**The Wilkinsburg (Pa.) Electric Light Company** is about to increase the capacity of its plant to ten thousand 16 c. p. incandescent lamps. The Thomson-Houston system is employed by this company.

**Bath, N. Y.**—The trustees of the village have signed a contract with the Western Electric Company, of Chicago, to furnish thirty-eight 2,000 c. p. arc lights for the street, to burn from dark till 1 o'clock a. m., 20 nights every month for $66 per lamp a year. The contract is to run five years.

**Windsor, Mich.**—A new electric light company has been organized, and will make application for incorporation at once. The organizers are: Aldermen Nash and Sutherland and W. C. Turner. The name of the new company will be the Windsor Electric Light and Power Company; capital $25,000. The plant of the old Windsor Gas Company is to be utilized as far as possible, but the dynamos are to be operated at the electric railway station.

**Columbus, O.**—Council has awarded several contracts for the supply of the municipal light plant. The Columbus Electric Company was given a contract for certain supplies at its bid. The Gamewell Fire Alarm Telegraph Company was given a contract for certain supplies amounting to $5,175; also, Messrs. Holmes, Booth & Haydens for furnishing 40 miles of No. 12 and 10 miles of No. 14 copper wire at $40 per mile; and the Standard Electric Works, 1,000 glass insulators at $30 per thousand.

**The Ohio Valley Electric Light and Power Company,** of Sewickley, Pa., one of the most prosperous and popular of Pittsburgh's suburban towns, is arranging to erect an additional central station plant, to be situated at Laurel, Pa., which lies midway between Sewickley and Pittsburgh. From this new station current will be used for the lighting of Edgeworth, Bellevue, Avalon and a number of other villages along the line of the Fort Wayne Railroad between Sewickley and Pittsburgh.

## THE ELECTRIC RAILWAY.

**Alameda, Cal.**—Theodore Metz has been granted a franchise to use electric motive power on his street car line.

**Mr. H. M. Barr,** of the St. Louis agency of the Edison General Electric Company, is in Lincoln, Ill., preparing a bid for the local street railway there.

**Athens, N. Y.**—A company with a capital stock of $35,000 has been organized to build an electric street railroad to connect the villages of Waverly, Sayre and Athens, N. Y.

**Pittsburgh, Pa.**—The Westinghouse Electric Company is preparing to lay a branch track from the Pleasant Valley Electric Street Railway to its works. The track will be used for shipping purposes.

**Pittsburgh, Pa.**—The Citizens Traction Company is about ready to begin the operation of its electric line running from Butler street, Pittsburgh, to Sharpsburgh. The Westinghouse system is the one adopted, and the cars will be running from the first of May.

**Waterloo, Ia.**—The city council has voted to modify the charter granted to the electric railway company, and a representative of a company of Chicago capitalists has entered into an agreement that the road shall be built this season, running over the present street car route and to Cedar Falls.

**The Worcester (Mass.), Leicester & Spencer Street Railway Company** has been organized to construct a road near Worcester Common through Leicester to Spencer. The road in all will be about 13 miles long and will probably be operated by electricity. The capital stock will be $250,000.

**Albuquerque, N. M.**—The Albuquerque Electric Street Railway has been organized. Arnold Beecher, of Chicago, and Jacob Boethm, of Denver, are the capitalists interested in the scheme. They will begin the construction of the road at once, and intend to have the line built and in running operation inside of six months.

**Franchise Granted.**—By a vote of ten to one the Plainfield (N. J.) Common Council, on Tuesday night of last week, granted to the Plainfield Street Railroad Company a franchise to operate in the city an electric street railway with trolleys and overhead wires. The awarding of the franchise will be completed when Mayor Gilbert signs the document.

**Ashland, Pa.**—The directors of the Shenandoah and Ashland Electric Railway Company have awarded to the Edison General Electric Company the contract for the construction and equipment of the plant. The road will cover 10¼ miles, to run from Shenandoah through Lost Creek, Girardville and Ashland, to Locust Dale. The cost will be $160,000. The work must be completed within 90 days.

**Storage Battery Cars in Washington.**—The two Edco storage battery cars installed upon the Eckington and Soldiers' Home Railway Company's track, in Washington, D. C., March 13, 1891, are said to be giving general satisfaction. On Sunday, April 19, the two cars carried 1,293 registered passengers, besides nearly as many transfers, the cars running on the G and Fifth street branch connecting with the main line of the Eckington Road on New York avenue, where the trolley system is used. A fair calculation would

therefore give 2,500 passengers carried by the Edco cars on that date. The greatest number of passengers registered on a single half trip was 75.

## GENERAL APPLICATIONS OF POWER.

**Mine Power in Canada.**—The first mining firm in Canada to call electricity to its aid in the practical development and working of its property, says the Victoria *Colonist*, is the new Vancouver Coal Company, at Nanaimo, B. C. Mr. Samuel M. Robins has long been studying the subject, and, having made up his mind that electricity is cheaper and safer than steam, he has placed an order for the necessary plant, to cost complete between $50,000 and $100,000, with Mr. John S. Anderson, of the Edison Electrical Company, Portland. The proposed electric plant will include an underground tramway, with power sufficient to maintain a uniform speed of eight or nine miles an hour, with 150 loaded cars continually moving. Six hundred incandescent lights are also to be used in the mines of the company, and the drills and cutters are to be operated from the same current. The new Vancouver Company will, in all probability, retain the honer of being the only firm in Canada mining by electricity but a very short time, as others are even now considering the subject.

## LEGAL NOTES.

**The Brush Electric Illuminating Company,** of New York, has procured from Judge Patterson, of the Supreme Court, a writ of certiorari to review the action of State Comptroller Wemple in levying on it, from 1881 to 1888, a tax amounting to $10,752.50. The tax has been paid, but under protest, the company alleging that it is exempt from State taxation.

**Ownership of the Patents for Producing Aluminium.**—In the case of Pittsburgh Reduction Company vs. The Cowles Electric Smelting and Aluminium Company, Judge Ricks granted an order restraining the defendants from increasing their present output of pure aluminium or from selling it at a price below that at which it is offered by the complainants at the beginning of the suit.

**Power of a City to Regulate Electric Railway.**—When an electric street railway company, organized under How. St. Mich. c. 95, has obtained and accepted in writing, as required by section 13 of the act, the consent of the Common Council, given by ordinance, to operate its road in certain streets, the ordinance providing that the poles shall be approved by the council before they are erected, the council cannot, after approving iron poles for the territory within the fire limits and wooden ones for that without, compel the company to furnish transfer tickets, without additional cost, in consideration of being allowed to erect the wooden poles, for such a condition is in conflict with section 14 of the above act, providing that a city shall not revoke its consent once given, nor deprive the company of the rights and privileges conferred. Where the council has adopted a report approving iron poles for the district within the fire limits and wooden ones for that without, a condition attached to the report that the company shall provide transfer tickets in consideration of being allowed to erect the wooden poles is void, and the council, having approved the pattern of the poles, as required by the ordinance, will not be compelled by *mandamus* to do it again, because of this void condition attached to the first approval. (Electric Railway Company *vs.* Common Council of Grand Rapids, Supreme Court of Michigan, 47 N. W. Rep., 567.)

## PERSONALS.

**Hon. Homer A. Nelson,** a well-known lawyer and the president of the Law Telephone Company, died last Saturday.

**Mr. F. E. Pettingell,** president of the Pettingell-Andrews Company, of Boston, sailed in the "Aurania" last Saturday for a brief vacation trip to Europe. He expects to be back in about six weeks.

**Mr. G. W. Hubley, Jr.,** of the engineering force of the Westinghouse Electric and Manufacturing Company, has gone to Portland, Ore., to accept a position with the Metropolitan Electric Street Railway Company, of that city, which is putting in an extensive road of the Westinghouse railway system.

## MISCELLANEOUS NOTES.

**The Frankfort Electrical Congress,** to be held in August next, will have for its American members Messrs. Bergmann, Brush, Edison, Hering, Sprague and Westinghouse, and Profs. Carhart and Dolbear.

**Employes' Building and Loan Association.**—At a meeting of the employés of the Laclede Gas Light Company and the Missouri and Municipal Electric Light Company of St. Louis, held at the office of the former, it was decided to form a building and loan association, to be known as the Gas and Electric. The capital stock was placed at $500,000, consisting of 2,500 shares of $200 each.

**The Pennsylvania Electric Light Association.**—At the continued meeting of electricians of Pennsylvania in the Anderson Hotel, in Pittsburgh, Pa., last week, a permanent organization of the above society was effected. Dr. George M. Getze, of the Tarentum (Pa.) Electric Light Company, was elected president, and A. C Overholt, of Scottdale, Pa., secretary. Much of the time was occupied in discussing methods best suited to the trade. Delegates from New Castle and Beaver were present, in addition to those from Pittsburgh, Scottdale, Sewickley, Wilkinsburg, Tarentum, Beaver Falls and Rochester, who had assembled on the week before.

## Industrial and Trade Notes.

**Messrs. Chas. A. Schieren & Co.,** of New York, are rushed with orders for their patent perforated electric belting. Their spring trade, especially in the electric railway line, has been immense, and the outlook was never brighter.

**Stanley & Hall,** the well-known electrical supply manufacturers have recently made several improvements in their electric bells, and have introduced new and improved machinery greatly improving their facilities for the manufacture of low-priced bells.

**"Simplex"** is the title of a small pamphlet issued by Mr. George Cutter, the western agent for the well-known "Simplex" wire. The little folder is gotten up in a nice shape, and contains, besides the price list and useful data, many terse and convincing statements.

**The Automatic Switch Company.**—Mr. Morgan, of the Automatic Switch Company, 8 Keyser Building, Baltimore, Md., says that he is as busy as it is convenient for him to be. Little need be said of the switch this company manufactures, since it is so widely and favorably known.

**Messrs. Blauvelt, Joy & Blauvelt,** of 258 Broadway, New York, are having a great run in the sale of their "Mitchell's transposition signs." That celebrated advertiser, W. L. Douglas, of $3 shoe fame, was among the first to recognize its value and is using them in large quantities.

**Enlarging Its Facilities.**—The alterations now going on at the quarters of the Crocker-Wheeler Electric Motor Company are nearly completed and promise an improvement both in the appearance and convenience of the premises. The company has nearly doubled the space formerly occupied by it.

**Mr. W. Hackenthal,** late agent in America for Prof. H. Aron's well-known electric meter, has discontinued his New York office, and hereafter all correspondence should be addressed to Prof. H. Aron, 6 Lützow street, Berlin W., Germany. Mr. Hackenthal has issued a circular and price list of the Aron counters.

**Mr. A. H. Massey,** 182 Jackson street, the Chicago representative of the Buckeye Electric Company is meeting with good success in the sale of the Buckeye incandescent lamps. Mr. Massey also represents the Western Mineral Wool Company of Cleveland.

**Viaduct Manufacturing Company.**—Mr. Davis, of the Viaduct Manufacturing Company, corner Charles and German streets, Baltimore, Md., reports a prosperous business. This concern is making a very handsome design of messenger call boxes, and is unusually busy manufacturing its new and very practical push button.

**The Williams Engine Works,** of North street, Baltimore, Md., take pride in the appearance and operation of their eight horse power engine. It takes up very little room, is said to be unusually efficient, and makes something like 800 revolutions per minute. One of these engines has been running seven years, it is said, without any repairs whatsoever.

**The Star Iron Tower Company,** of Fort Wayne, Ind., manufacturers of towers and mast-arms for electric lighting, has issued a beautifully illustrated pamphlet showing some of the principal tower mast-arm arc light installations of this company. The pamphlet contains also the price list of the company, besides much information of interest to those contemplating lighting.

**The Standard Paint Company,** manufacturers of the widely-known "P. & B." protective paint, has issued a pamphlet containing copies of a large number of letters recommending the "P. & B." paint as a protective coating against moisture, acids, salt water and all corrosive substances, and as an insulator for electric purposes. The pamphlet also comprises a price list of these paints.

**Removal.**—The Acme Specialty and the Electrical Specialty Companies, now located on Cortlandt street, New York City, will remove to the fifth floor of the new Electrical Exchange building rconer of Liberty, Washington and Cedar streets, on May 1. The Electrical Specialty Company has a new medical battery and electric bell, for which the company has so far been unable to supply the demand.

**Messrs. J. K. Miles & Co.,** of the Union Export and Trading Company, Drexel Building, Philadelphia, is a firm all manufacturers of electrical goods should become acquainted with. They have established through Mexico, Central and South America, 27 branch agencies, who are daily sending orders for all sorts of American products. Electrical machinery and supplies are being shipped quite largely.

**Change of Firm Name.**—The Keystone Electric Works of Harrisburg, Pa., has been succeeded in business by the Entrekin-Elder Electric Company. This company has increased the capital stock, provided improved facilities, and added a large force of laborers. It proposes to do an electrical business second to none in the State, and is now the only house in central Pennsylvania carrying a general line of electrical supplies.

**The Partrick & Carter Co.,** of Philadelphia, has devised a very useful fixture for exhibiting electrical house goods by those dealers who cannot carry a large stock, but want something to show intending customers the various styles of bells, annunciators, pushers, etc. This is a sample board of walnut or ash, with a collection of the specialties manufactured by this firm. The company issues a descriptive circular of this new sample board.

**A. L. Bogart,** of 22 Union Square, New York City, has just issued a pamphlet containing full and explicit instructions for the installation and operation of multiple electric gas-lighting apparatus. By following the plain directions as given the amateur can successfully install and operate in a practical way a multiple gas lighting plant without difficulty. The pamphlet also contains an illustrated description of the supplies needed in such a plant.

**Mr. George L. Kirkham,** manager of the Northwestern Electrical Specialty Company, 1,017 Chamber of Commerce, Chicago, is certainly doing all in his power to convince the users of incandescent lamps that the Economic lamp is rightly named, judging from the interesting communications he is sending broadcast. In the handling of specialties Mr. Kirkham is well equipped, and, being popular and a good business man, success is crowning his efforts.

**Messrs. Dean Brothers,** of Indianapolis, Ind., manufacturers of the celebrated Dean pumping machinery, have issued their catalogue, "No. 17," for 1891. This book contains descriptions and list prices of most of this company's extensive list of steam pumping machinery, with directions for ordering and setting up, besides containing much useful data for steam engineers. The cuts have all been made from photographs and show the machinery to advantage.

**Mr. George O. Fairbanks,** the general district agent of the Westinghouse interests, has one of the finest suite of offices in Chicago, having moved from the ground floor to the ninth floor of The Rookery, where his offices all face on Adams street, or the court leading from Adams to Quincy. The offices are handsomely fitted up and reflect credit on the great companies that Mr. Fairbanks represents and will prove advantageous headquarters for many of their numerous out-of-town customers.

**P. B. Delany,** the well-known electrical engineer, who is located at South Orange, N. J., has a number of new specialties he is now about placing on the market. Among them are his new telephone system, a unique binding post, so arranged that the upper piece cannot slip off, a cable system for the use of the Morse alphabet through submarine cables, and a bell which is of the ordinary type except that a muffler is added, making no appreciable difference in its cost, but giving a soft, low sound.

**The L. J. Wing Company,** of 126 Liberty Street, New York City, is the manufacturer of the Wing disc fans, high speed engines, electric motors, dynamos, fan ventilators, gas engines, etc., for heating, ventilating, cooling, drying, removing dust, smoke, steam, etc. Isolated lighting by electricity for private residences, stores and small hotels, is now a large part of this company's business. The Wing fans are peculiarly suitable for electric light companies, because of the small amount of power consumed by them. They obstruct light but little and are practically noiseless.

**The Pelham Bay Park Electric Light, Power and Storage Company,** which is operating under the patents of George Whiteman Cochran, is now located at Room 32, No. 18 Broadway, with Mr. Benjamin Franklin as its executive head. The new cell manufactured by this company—size, 14 by 14, 4½ inches wide—is claimed to give 300 ampère hours without buckling. The company is lighting Pelham Bay Park, and has just secured the contract to light Belden's Pleasure Resort with both arc and incandescent lights. The company is also fitting up two launches to run by electricity.

**The Interior Conduit and Insulation Company** has taken possession of its new offices in the new Edison Building, 42 and 44 Broad street, this city. The two large rooms in front are occupied respectively by Mr. E. H. Johnson, president, and Mr. E. W. Little, general manager, and are substantially furnished in hard wood. Mr. E. T. Greenfield, the company's electrician, has his office, draughting and show-rooms directly back of Mr. Johnson's office, and Mr. F. A. Mason, in charge of the financial department, has his office adjoining. All the conveniences usually found in a suite of well-appointed offices make these headquarters suitable for such a progressive company.

**Graphite Paint for Central Stations.**—The life of an ordinary roof or outside paint runs all the way from three to five years, and it should be of personal interest to many who know of a paint that will resist acids or alkalies and withstand the wear and tear of the elements for 10 or 15 years. This seems to be a remarkable length of time, but the statement is vouched for by well-known people who have used Dixon's graphite paint made by the Jos. Dixon Crucible Company, of Jersey City, N. J. They claim that graphite paint is not only durable but handsome and equally useful for all outside wood or metal work where dark paint can be used. It is frequently used on the exterior of electric light and power stations.

**The Improved Hussey Bluestone Cell.**—The above battery cell, manufactured by the Crosby Electric Company, of New York City, needs no introduction. The sales of the Hussey cell in the large supply houses during the last year speak more for its merits than anything else. The chief characteristic of this cell is that, unlike other gravity cells, it works from the beginning without having to be short circuited. No acid is used, and the ease with which it can be put up has won for it many commendatory testimonials. The price of the improved Hussey cell is $1.25. Among the many letters of recommendation received regarding the above battery cell are communications from the following: C. D. Shivler, secretary and treasurer of the American District Telegraph Company, of New York City; R. E. Alexander, assistant general manager Westchester Telephone Company, of Yonkers, N. Y., and W C. Smith, superintendent New Haven Fire and Telegraph department at New Haven, Conn.

**Sales of Ide and Ideal Engines.**—A. L. Ide & Son, Springfield, Ill., report recent sales of their engines to railway and electric light companies as follows: Davenport & Rock Island Railway Company, Davenport, Ia., seven engines of 1,050 h. p; Rockford City Railway Company, Rockford, Ill., one engine of 150 h. p.; Joplin Electric Railway and Motor Company, Joplin, Mo., one engine of 150 h. p.; St. Louis Railroad Company, St. Louis, Mo., two engines of 80 h. p.; Chicago City Railway Company, Chicago, Ill., two engines of 235 h. p.; Bowling Green Electric Company, Bowling Green, Mo., one engine of 70 h. p.; Electric Wheel Company, Quincy, Ill., one engine of 105 h. p.; Danville Gas, Electric Light and Street Railway Company, Danville, Ill., two engines of 300 h. p.; South Denver, Electric Company, Denver, Colo., one engine of 150 h. p.; Rapid Transit Company, Salt Lake City, Utah (second order), one engine of 225 h. p.; Edison General Electric Company, St. Louis, Mo., one engine of 35 h. p.; Davenport & Rock Island Railway Company, Davenport, Ia. (2d order), one engine of 25 h. p.

**A Flexible Tin Shade.**—Tin shades for use in deflecting the rays from an incandescent lamp are no longer a novelty, there being half a dozen different styles on the market. But one now placed on the market by the Knapp Electrical Works, of Chicago, is entirely new in principle, simple in construction, easy of manipulation, and is one of the most convenient accessories to an incandescent lamp that has yet appeared. It consists of two sheets of tin pressed into the required shape and hinged across the centre, while attached to the rod are two ratchet wheels that enable either half of the shade to be placed at any angle desired, or both sides may be closed entirely. The manifold advantages of such a shade are obvious, and the Knapp Electrical Works are careful to see that each shade is mechanically perfect and handsomely finished in order that they may harmonize with interior decoration. An additiona advantage consists in the holder being arranged to fit any type of socket, thus necessitating no additional expense. However, the shade can be furnished with or without a socket, as the purchaser may desire.

**The Eastern Electrical Supply and Construction Company** has leased the whole building at 65 Oliver street, Boston, and is rearranging its offices. Mr. G. E. Wallace, manager of the railway department, and Henry F. Kellogg, manager of the light and power department, secure under the new order of things especially light and pleasant offices on the second floor. The repairing department of this company, which is operated as a specialty at its factory, is unusually busy, many thousands of dollars worth of machinery being now in course of overhauling. The Eastern Company has arranged for the exclusive control of a new door-pull which President Brown says will monopolize the market. It is expected to be ready in a few days. A late addition to the company's force is W. S. Teeples, formerly of the Sawyer-Man Company, who will represent them throughout the West. For a new company starting within the last six months these gentlemen have certainly made rapid progress. Their business during the last 30 days is said to have been over four times as much as it has been for any other one month.

**Electric Railway Supplies.**—It is not often that a new company starts out to fill an unoccupied but growing field and makes a success of its work from the start. But that is exactly what the Electric Merchandise Company, 11 Adams street, Chicago, has done under the able management of Mr. W. R. Mason. Its one specialty is the supplying of everything pertaining to the construction, operation and maintenance of electric street railway lines irrespective of the system used, and although the growth of that particular branch of the electrical industry has been unprecedentedly rapid, yet this company has kept pace with every improvement and to-day can furnish from stock every article required, from a special form of gearing to the latest improvement in an automatic cross-over for trolley lines. An indication of the popularity and growth of electric railways is also shown by the fact that the Electric Merchandise Company has now four traveling men on the road, Mr. D. B. Dean, Mr. W. R. B. Wilcox, Mr. Frank X. Cicott, manager of the rail department, and Mr. A. H. England, the affable secretary of the company, who occasionally goes out to close special contracts. The company is shipping orders for rails alone at the rate of nearly 500 tons per week, and as soon as the capacity of the plant it controls is increased, it is expected that a greater quantity will be disposed of. Mr. Mason, having been elected president of the Burton Electric Company, has gone to Richmond, Va., to attend the business meetings of the company, and reports that the Burton company will shortly bring out some new and improved devices in connection with electric heating.

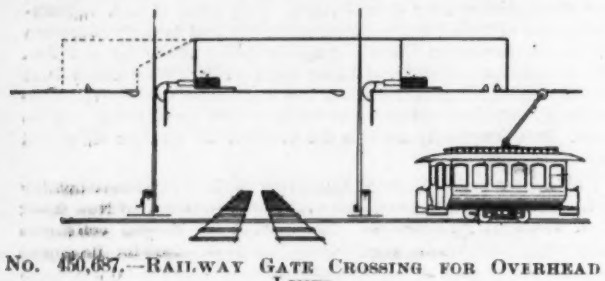
# OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

## U. S. PATENTS ISSUED APRIL 21, 1891.

**450,605. Socket for Incandescent Lamps;** Geo. H. Alton, of Lynn, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed Oct. 22, 1890. A lamp-socket comprising an insulating base, a U-shaped terminal attached thereto and adapted to be screwed into the collar of the lamp, thereby making connection with one lamp-terminal, and the spring terminal permanently fixed to the base at one end and having a free end which is pressed into engagement with the second lamp terminal upon screwing the lamp to the socket.

**450,613. Electric Railway;** Frank Sterling Culver, of Eau Claire, Wis. Application filed Sept. 25, 1890. An electric railway trolley, consisting of a slotted bar, a wheel at one end of the bar and another wheel having its axle movable along said bar, and a spring within said slot, and connected to the bar at one end. (See illustration.)

**450,615. Means for Communicating Information;** Patrick B. Delany, of New York. Application filed Nov. 26, 1888. This invention employs the letters of the alphabet and the numerals in



No. 450,687.—RAILWAY GATE CROSSING FOR OVERHEAD LINES.

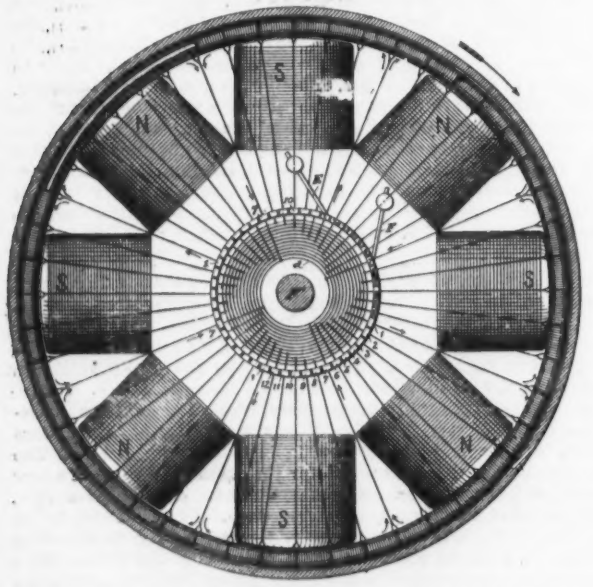
connection with lights, each of which when lighted or flashed displays its corresponding letter or number. The letters and numerals may be arranged upon a transparency, in the rear of which the lights are flashed. (See illustration.)

**450,626. Safety Device for Overhead Electric Wires;** Max Kersten, of Boston, Mass. Application filed Jan. 30, 1891. The invention consists of a pair of rods or wires made of conductive material and covered with insulating material, said rods connecting a pair of metallic bars.

**450,628. Wall-Socket for Incandescent Electric Lamps;** Philip Lange, of Pittsburgh, Pa., Assignor by mesne assignments to the Westinghouse Electric and Manufacturing Company, of same place. Application filed June 11, 1890. The combination, with a base having a recess and a flange of an insulated lamp receiving cup within said opening, a central contact and the terminal plates carried by the flange.

**450,630. Printing Telegraph;** Samuel R. Linville and Louis F. Hettmansperger, of Philadelphia, Pa., Assignors to the Keystone Battery and Electric Supply Company, of Camden, N. J. Application filed June 23, 1890. A printing telegraph system comprising a source of electric energy and electrical and mechanical devices located at a station for alternating the polarity of the current in a single line, transmitting and receiving instruments looped in the line, and each instrument provided with type wheels, means at said station for arresting the alternating devices responding to different condition of current, keys in any transmitter, type wheel, shifting and impression devices, and mechanical and electrical devices respondin : at each instrument to a break or weak current in the line caused by the depression of any key of said transmitter to effect the arrest of the type wheels at a position to present the character as indicated by the depressed key to the impression device.

**450,631. Printing Telegraph;** Samuel R. Linville, of Philadelphia, Pa., Assignor to the Keystone Battery and Electric Supply Company, of Camden, N. J. Application filed Aug. 12, 1890. A print-telegraph system comprising sources of electric energy



No. 450,975.—DYNAMO-ELECTRIC MACHINE OR MOTOR.

parallel and series circuits, electrical and mechanical devices located at a station for alternating the currents in parallel circuits, arresting devices at said station responding to electrical impulses in a series circuit, transmitting and receiving instruments included in said circuits, keys in said instruments, and electrical and mechanical devices responding to said keys to close said series circuit and to arrest said alternator.

**450,639. Electric Motor or Generator;** John F. Seiberling, of Akron, O. Application filed Nov. 17, 1890. In an electric motor the pole pieces of the field magnets, constructed each in two parts, one of which is made adjustable laterally relatively to the other.

**450,641. Self-Exciting Alternate-Current Electric Generator;** William Stanley, Jr., of Great Barrington, Mass., Assignor to the Westinghouse Electric and Manufacturing Co., of Pittsburgh, Pa. Application filed Oct. 19, 1888. A self exciting alternate-current electric generator, having two or more independent sets or armature coils, an electric converter wound with two independent coils, one connected in series with the field-magnet coils of the generator, the other in series with the work circuit, each arranged to lessen the self-induction of the other, said converter being mounted upon the armature shaft and revolving therewith, and a rectifying commutator interposed in the field-magnet circuit.

**450,645. Railroad Signaling Apparatus;** John D. Taylor, of Piketon, O. Application filed July 18, 1890. This invention consists in the combination of a polarized relay for receiving the signal from the main line and operating the local circuit and electrically operated signal receiving and transmitting devices.

**450,646. Electric Railway Block Signal;** John D. Taylor, of Piketon, O. Application filed Sept. 9, 1890. In an electric railway block signal, the combination of the semaphore, the semaphore operating motor, the break wheels operated by the said motor, the polarized relay, the plain relay, the track instrument, and the electrical connections.

**450,652. Electric Locomotor;** George Westinghouse, Jr., of Pittsburgh, Pa. Application filed Aug. 1, 1890. The combination, with an electric motor, of a car truck having two or more pairs of wheels, means for driving one pair of wheels by the operation of the motor and friction wheels coupling said wheels with another pair of wheels of the truck, said friction wheels supporting one end of the motor, whereby the pressure exerted by the friction wheels is increased by the torque of the motor.

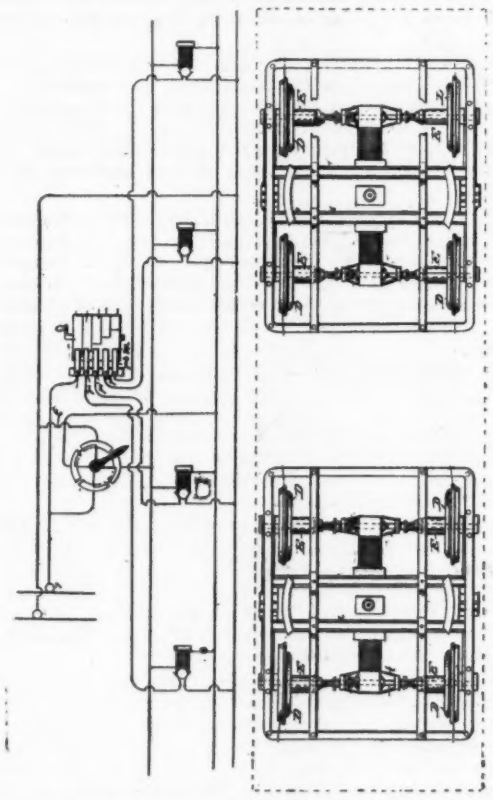
**450,683. Trolley or Traveler for Electric Railways;** Sidney H. Short, of Cleveland, O., Assignor to the Short Electric Railway Company, of same place. Application filed April 9, 1890. A trolley or traveler for an electrically-propelled vehicle, comprising contacts insulated from each other for establishing connection of the vehicle with separate supply conductors and provided with a device projecting beyond said contacts and free at the outer edge and adapted to enter between said supply conductors for guiding the contacts to their operative position on the conductors and to act as a guard against lateral displacement of the same.

**450,687. Railway Gate Crossing for Overhead Lines;** Elihu Thomson, of Lynn, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed May 5, 1890. The combination, with a railway gate, of an electric line conductor crossing the path of said gate and provided with a removable bridging section actuated by an electromagnet and circuit connections for operating said electromagnet. (See illustration.)

**450,690. Clamp Electrode for Electrical Dental Apparatus;** Thomas Stewart Wilson, of Chicago, Ill. Application filed Oct. 22, 1890. In a clamp electrode to be used in connection with an electric dental apparatus, a clamp and an electrode provided with stirrups connected with movable arms.

**450,706. Electric Bell-Pull;** Lemuel B. Tinkham, of Boston, Mass. Application filed Oct. 11, 1890. An electric bell-pull comprising a knob and shank, a carriage having an opening therein, a roll in said opening, and one or more springs projecting over said opening, one of said springs being insulated from said carriage, whereby as the shank is withdrawn the roll is moved and the circuit made.

**450,708. Insulator;** Theodore Creighton, of Tiffin, O. Application filed June 19, 1890. An insulator integral in all its parts, consisting of a stem and a head formed with an annular groove



No. 450,742.—ELECTRICAL PROPULSION OF VEHICLES.

and a direct transverse central hole through the plane of the groove and adapted to receive an ordinary lightning rod.

**450,734. Electric Cable;** William I. Bunker, of La Grange, Ill. Application filed Oct. 7, 1890. An electric cable composed of a series of conducting particles adapted to contact with each other to transmit a current.

**450,742. Electrical Propulsion of Vehicles;** Edward H. Johnson, of New York. Application filed April 8, 1890. The method of operating an electrically propelled vehicle, which consists in successively closing circuit to two or more electric motors mechanically connecting with the wheels of the vehicle in starting the same. (See illustration.)

**450,834. Method of Making Plants of Secondary Batteries;** Stanley Charles Cuthbert Currie, of Philadelphia, Pa. Assignor to the United States Gas Improvement Company, of same place. Application filed Nov. 18, 1890. The method of making a battery plate or element, which consists in fusing the salt or salts of a metal, casting and attaching the fused mass to and between a woven envelope and a core forming the matrix in said mass by removing the core, and attaching the mass to a support by casting fused metal into the matrix and reducing the cast salt or salts to the metallic state by eliminating the acid there from.

**450,839. Method and Apparatus for Covering Electric Wires;** Application filed Sept. 30, 1884. The method of covering wire with sheet metal, the same consisting in bending the strip around the wire or wires and forming lips or raised edges upon said strip, and then burning said edges together.

**450,840. Galvanic Battery;** Charles Wilms, of Baltimore, Md. Application filed Dec. 6, 1890. The combination of a sealed battery cell and an inclosing case of wood, rubber or other similar material having a cell-space larger than the cell, and affording space for the battery material when released from the cell.

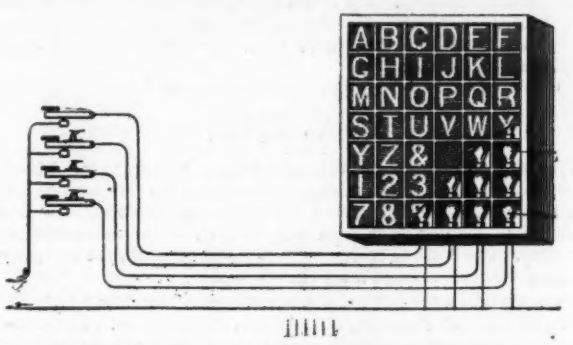
**450,846. Insulated Electric Car;** John Stephenson, of New York. Application filed July 5, 1890. An electric car having a bridge mounted upon its upper surface and an electric trolley supported on the bridge, and having electric insulators interposed between the bridge and the upper surface of the car-body.

**450,853. Trolley-Wheel Support for Electric Cars;** Harold A. Webber, of Passaic, N. J. Application filed Aug. 13, 1890. A trolley-wheel support, consisting of a lower plate connected with the upper end of an arm, the upper plate free to rotate and having an extended bearing upon the lower plate, and provided with bearings for the trolley-wheel, and means for securing the plates together.

**450,872. Electric Valve Controller;** Charles B. Reardon, of Franklin, Pa., Assignor of one-half to John E. Gill, of same place. Application filed June 4, 1888. The combination, with a hydraulic valve, of a tilting lever connected thereto, having a solid and a hollow weight at its ends, and electromagnets, the circuit wires of which extend through a hose and are operated by a switch at the nozzle, a valve discharging into the hollow weight when raised, and a valve emptying the hollow weight when lowered.

**450,875. Electrically Propelled and Steered Torpedo;** Winfield S. Sims, of Newark, N. J. Application filed Dec. 22, 1890. The combination, with a torpedo, of a steering magnet, an electrical generator, a relay for directing current through the steering magnet, a resistance in a shunt around the relay contacts, and means for opening the shunt after the relay contacts are separated.

**450,896. Thermostat;** Jesse C. Sims, of Mynard, Mass. Application filed Nov. 29, 1890. A thermostat comprising a thermometer provided with a bulb and tube containing mercury, a series of lateral branch tubes connected with the thermometer tube and containing wires sealed in the lateral tubes and extending to the bore of the thermometer tube, rods and sliding blocks, placed on the rods and adapted to receive and clamp the electric wires.



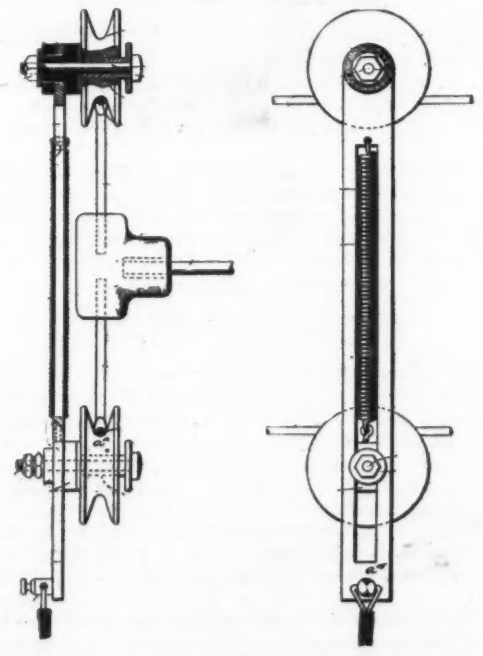

No. 450,615.—MEANS FOR COMMUNICATING INFORMATION.

**450,923. Electromagnetic Apparatus;** Leonidas G. Woolley, of Grand Rapids, Mich. Application filed Aug. 16, 1890. The combination, with an induction coil of two circuits for the primary coil, a manual circuit closer in one circuit, and a switch lever controlled by gravity in the other circuit, both including a vibrating rheotome, whereby the device is adapted for use either as an ordinary electromagnet or for the production of secondary currents.

**450,927. Automatic Electric Valve Controller;** Ferdinand E. Chatard, of Baltimore, Md. Application filed Jan. 15, 1891. The apparatus consists of a magnetic mechanism constructed to operate a heat controlling valve and a thermostat situated in the apartment to be heated, and controlling electric circuits through which the valve mechanism is actuated.

**450,970. Electric Motor Mechanism;** Samuel E. Mower, of New Haven, Conn., Assignor to Henry G. Thompson & Sons, of same place. Application filed Nov. 4, 1890. The invention consists of the following instrumentalities, viz.: An axle, an electric motor, its armature, a counter-shaft gearing connecting said armature and counter-shaft, a sprocket wheel loose on said counter-shaft; a sprocket wheel on said axle, means to connect said sprocket wheels, and mechanism to render the loose sprocket wheel fast on the counter-shaft.

**450,973. Electric Switch;** John Amidon Norton, of Bridgeport, Conn. Application filed Sept. 26, 1890. An electric switch, having with suitable terminals a rotative block, circuit-closing



No. 450,613.—ELECTRIC RAILWAY.

arms pivoted to said block, and having a movement parallel with the axis of said block, and springs adapted to operate said circuit-closing arms.

**450,975. Dynamo-Electric Machine or Motor;** Albert L. Parcelle, of Boston, Mass., Assignor to the Simplex Motor Co., of Maine. Application filed Oct. 14, 1890. The combination of a fixed hub or frame carrying the field-poles, the surrounding ring-armatures having multipole coils, and the casing surrounding and carrying the armature and interlocking and rotating therewith. (See illustration.)

**450,985. Electric Current Regulator;** Joseph Archibald Williams, of Cleveland, O. Application filed Nov. 15, 1890. The invention consists in the combination of a compound thermostatic bar with the circuit wires of a dynamo, a pair of compound thermostatic bars oppositely arranged with respect to each other, connected with the movable brush-holding bar, and current-shifting devices arranged to throw the current into one or the other of the secondary compound thermostatic bars.

**450,991. Ceiling Rosette for Incandescent Lamps;** David J. Cartwright, of Boston, Assignor to John S. Potter, of Newton, Mass. Application filed Nov. 10, 1890. A ceiling rosette for incandescent lamps, consisting of a block of insulating material having an annular ring or lip on its upper side, combined with a pair of radial metal arms secured to said block and projecting through cutaway portions in the annular lip, said arms having their inner and outer ends provided with binder screws for securing them to the respective lamp and circuit wires.

*Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired, and address The W. J. Johnston Co., Ltd., Times Building, N. Y*